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HANDBOOK FOR OPERATION AND MAINTENANCE OF AN NBS MULTISENSOR AUTOMATED EM FIELD MEASUREMENT SYSTEM

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A system is described that monitors and collects electromagnetic (EM) field strength information at five (optionally 10) locations simultaneously. The system has two modes of operation: (1) for sampling EM fields that are stationary for times of the order of 200 ms, and (2) for sampling changing EM fields with a system resolution of 10 μ s. Sensing elements for Mode 1 consist of three electrically short orthogonal dipoles mounted together, single dipole elements, or small loop antennas. Each element feeds a separate data input channel for a total of 15 (optionally 30) channels. Rf energy is converted to dc by a diode detector at each dipole. Mode 2 sensors will be diode detectors driven by broadband antennas. Real time system data processing includes calculation of field strength based on probe calibrations and processing of resultant data to satisfy measurement goals.

Key words: automated measurement; electromagnetic field probe; high impedance; high speed; simultaneous sampling.

1. GENERAL INFORMATION

1.1 Introduction

This system was developed in response to work performed at the National Bureau of Standards (NBS) directed toward characterization of the EM environment in reverberation chambers [1]. One approach to mapping the EM fields in a test chamber is to use a single probe and move it through the area while continuously sampling the probe response. This has been done using a track made of nonconductive materials on which the probe is mounted. This method works well for environments which are stable and require a single probe reading at each location. However, some measurements require a large number of readings at each location (for example, to compute the average field during one rotation of the tuner in the reverberation chamber) which makes the track method very time-consuming.

A second method [2] uses several stationary probes at selected positions throughout the test volume. This approach is more appropriate when multiple readings are needed at each location. Problems associated with determining the physical location of the probe and with the perturbation of the EM environment due to bulky dielectric objects (track hardware) are minimized with the multiple probe system.

1.2 Background Requirements

The system described in this report is the second generation implementation. The list of specifications for the amplifier and data handling portion of the system, includes the following desired characteristics:

- a. Multiple sensor input with adjustable gain to accommodate a wide variety of probes.
- b. Parallel data acquisition for simultaneous reading of all probes.
- c. Interface to desktop microcomputer (for control and data processing).
- d. Channel modularity for reliability and maintenance.
- e. Minimum size and weight.

In addition to the above, it was desired that the antennas and signal detection portion of the system produce the maximum bandwidth possible for the detected signal. While thermocouple detectors have good rms conversion characteristics and high rf frequency response, they are relatively insensitive and have response times of the order of 1.0 s, which is considered slow for our applications. To reduce response time, Schottky N-type beam-lead diodes with low barrier and as high a frequency response (low capacitance) as possible were chosen. A reverse breakdown voltage of 4 V results in an anticipated maximum measurable field strength of 1.5 kV/m.

1.3 Implementation

The system consists of an interface and backplane assembly with addressing capability of up to 31 card slots. (This number may be increased by adding address lines to the hardware, but the need for a larger system has not yet appeared). Each card slot will support one amplifier/digitizer circuit card containing the analog amplifiers, analog to digital (A/D) converter, and support circuits. The system samples all enabled inputs simultaneously by strobing the A/D converters on each card in parallel. After all signals have been converted from analog to digital representation, the digital numbers are read out serially under control of the desktop computer.

A system may be configured to utilize any or all addressable card slots. The two systems currently being used have 15 and 30 channels.

This manual is written for the 15-channel (5-probe) system. It is understood that the discussion would equally well apply to a system of 30 channels (10 probes), the only difference being the presence of more hardware and the additional time required to read twice as many channels after conversion.

1.3.1 Functional Diagram

Figure 1 shows the functional circuit blocks comprising one channel of this 15 channel system. An antenna probe and resistive leads (not shown in figure 1) supply a balanced, slowly varying dc voltage to the input labeled "Balanced High Impedance Inputs." From here the signal is filtered, amplified, switch-selected, and fed to an A/D converter. Upon command, the converter converts the signal to a 13-bit digital number (12 bits plus sign). The interface, under control of the desktop computer, transfers the digital number to the computer. All 15 channels begin conversion simultaneously. When all converters are finished, the computer sequentially reads data from each converter. The system is reset and is ready for the next measurement cycle.

1.3.2 Probes

This system was designed for use with two types of antennas or sensing probes: (1) high-impedance, slow-speed, 8-mm dipoles which are supplied with the system, complete with connecting cables, and are described below; (2) low-impedance (50 to 2000 Ω), high-speed probes for pulse work which are not supplied with the system and will not be discussed further in this document. Input circuits for future (optional) high-speed probes are, however, discussed in the following section on input circuits.

The five high-impedance probes supplied with the system were developed at NBS and are described in detail elsewhere [3]. The five probes each consist of 3 individual miniature dipoles arranged orthogonally to pick up electric fields independently of the direction of arrival. The probes have an isotropic response of ± 0.3 dB up to 8 GHz. They are designed to measure fields from 10 to 1600 V/m. The frequency range is from below 100 MHz to 8 GHz. The initial shipment of probes has response from 8 to 12 GHz but with some degradation of pattern. This implies an amplitude uncertainty of the order of ± 3 dB in the range from 8 to 12 GHz, in addition to the system accuracy of ± 1 dB.

Each individual dipole is a miniature, resistively loaded, tapered dipole 8-mm long, as shown in figure 2. By itself it has a spectrum response flatness of ± 2 dB. However, since the use is intended for single frequency test environments, amplitude corrections as a function of frequency are applied in the computer section of this system, producing a system flatness of ± 1 dB between 300 MHz and 8 GHz. The system can be used at frequencies down to 100 MHz but flatness between 100 and 300 MHz is ± 2 dB. Below 100 MHz and for lower strength fields, other members of a family of probes may be used.

1.3.3 Input Circuits

The system has two sets of input ports with two different specifications. The primary set, intended for use with the supplied probes, has a high-impedance input and a slow response time. This signal path, when selected, is directly connected to the analog to digital converter which has a conversion time of about 200 ms. This requires that input signals be stable (1 part in 4000) over this 200 ms time period. These inputs are referred to as High-Impedance (HI) throughout this handbook. They are

accessible through 50-pin D connectors on the rear of the equipment and are intended to be used with 8-mm dipole probes connected by high-resistance carbon-loaded leads.

The second set of inputs is intended for a higher speed response and lower impedance antennas and detectors. The inputs are sampled by a sample-and-hold circuit, which is triggered by a pulse either from the desktop computer or from an external source. This sample-and-hold circuit has an aperture uncertainty time of about 10 μ sec, which means input signals should be stationary for that length of time. The input preamplifier preceding the sample-and-hold circuit, has a bandwidth of 100 kHz, which matches the 10 μ s specification of the sample-and-hold circuit. This amplifier inverts the input signal and has a fixed amplitude gain of 50. A switch connects both types of input to the A/D. As with the slower speed input, the A/D speed is about 200 ms, with the sequential readout of all channels after conversion requiring another 250 ms or so. The total time between high speed samples can therefore be no less than about 500 ms.

1.3.4 Computer Software

The software was initially developed on a *Hewlett-Packard (HP) 9836. However, it is intended to operate on any HP series 200/300 machine. The GPIO interface discussed in this handbook is common for all models in this series. Software details are discussed in section 3.0.

2. EQUIPMENT SET UP AND OPERATION

2.1 Cabling

Figure 3 shows the cabling diagram for the rf probe system. Supplied high impedance probes are shown. Optional high-speed components are not shown.

Shielding of resistive line leading from the probes to the bulkhead box (and their hardwire lines on to the interface) may be accomplished using any of several means to suit local conditions. Common-mode rejection and filtering remove most 60 Hz stray pickup, but the high impedance of the input (about 20 M Ω) makes some shielding of open lines desirable.

2.2 Computer GPIO Card

Figure 4 shows a diagram of the GPIO card (HP 98622A) which is inserted into the back of the computer. The switches on the card must be set as shown in figure 4 for the system to operate properly.

*Certain commercial equipment is identified in this document. This identification does not imply endorsement by the National Bureau of Standards nor does it imply that the equipment identified is necessarily the best available for this purpose.

2.3 Amplifier/Digitizer Configuration

The system consists of a series of identical amplifier/digitizer modules or channels, each of which has a unique address which the computer uses to interrogate the output of the A/D converter. For proper operation each amplifier/digitizer channel must be configured for the specific measurement and reside at a unique and legal address. (Note: each isotropic probe requires three channels, one for each of the three antennas). The amplifier operation may be configured on the front panel. The address is set on the circuit board using the ADDRESS-SELECT switches.

2.3.1 Front Panel

The front panel shown in figure 5 is typical of each amplifier/digitizer channel. The panel controls allow the operator to select either the high-impedance or the high-speed amplifier section (switch 15, lower left position), and to adjust the zero drift of each section independently via the active/zero switches (switch 13 in the upper left position for high-impedance, and switch 16, upper right, for high-speed) and their respective zero-adjust trimmer potentiometers (R9 and R12). The gain of the high-impedance amplifier may be changed with the GAIN-SELECT knob (switch 14) located in the center of the panel. The gain values are related to the resistors associated with each switch setting and may be tailored to meet specific needs (i.e., a new generation of probes with different output levels). The final feature on the front panel is a channel select indicator light (lower right position) which indicates when this particular card has been addressed by the computer.

The high-speed section is not currently utilized and setup criteria are left for future applications. The remaining discussions involve only the high-impedance amplifier section with the associated probes mentioned in section 1.3.2.

2.3.2 Front Panel Setup (High-Impedance)

The switch settings shown in figure 5 indicate normal operation of the high-impedance amplifier. The high-impedance amplifier is selected (switch 15) and the input signals are connected to the amplifier by setting switch 13 to 'active'. It is assumed that the individual channels have been previously aligned. Alignment is needed if the digital output is not zero for a zero input (switch 13 set to 'zero') or if other problems are noticed. Refer to section 4.2.1, Alignment and Test Points for the recommended procedures.

2.3.3 Amplifier/Digitizer Card Address

When the input signal from each probe has been digitized, each A/D is interrogated in turn by the controlling desktop computer. Each A/D is accessed by the computer calling for one of fifteen addresses or channels sequentially one after the other. If an amplifier is inserted or replaced in the channel numbered 1, to be properly interrogated in sequence as the first amplifier, the address switches must be set to 1. Figure 6 shows the location of the address switch and an example address for channel 1. Note that only the first 10 positions of the switch are used. Also note that

when rocker switches are used, the depressed side selects the function; on slide switches the raised portion denotes the function selected. Both rocker and slide switches are installed with open (off) to the left, and closed (on) to the right. Figure 7 shows the address select switch coding needed to select up to 31 channels; only the first 15 are used in this equipment.

2.4 System Operation and Software

First the system hardware is assembled. Next the computer is booted up in its basic operating system, and the software supplied with the system is loaded into memory. Operation is commenced by depressing the run key. A detailed discussion of the software is covered in Section 3.

3. SYSTEM SOFTWARE

The software for the NBS multi-probe system is written for Hewlett-Packard series 200/300 laboratory computers in HP Enhanced Basic. The program controls the GPIO interface and supplies all control signals to the probe system hardware. As may be observed by looking at the hardware information, the probe interface board has no provisions to latch information and relies entirely upon the GPIO card to maintain internal conditions.

The program allows the operator to configure the system to any given combination of probes and amplifiers within the limits of the available hardware and to extract the correct calibration data for that antenna.

3.1 SUB Program Descriptions

The software allows relatively simple integration into larger measurement programs. The multi-probe system is recognized as part of a larger rf generation and measurement laboratory system, and the measurement programs will consist of modules controlling many different instruments. The multi-probe system programs are constructed as SUB programs that may be loaded and CALLED by the main program written by the user. These modules (SUB programs) are defined as follows:

- 1) Multiprobe_menu
- 2) Read_probes
- 3) Probe_fill_cal
- 4) Apply_probe_cal
- 5) Get_cal_value (general purpose)
- 6) Errortrap (general purpose)

These modules are interrelated; 'Multiprobe_menu', 'Read_probes', and 'Apply_probe_cal' provide the necessary linkage to a main program. A description of the structure and functions of each module follows.

3.1.1 Multiprobe_menu

This module provides all the system definitions and linking parameters necessary for operation of the system. A series of parameters defines the

hardware configuration and the number of antennas available to the system. These parameters are defined in the program listing given in appendix I.

An array of index values is established as a result of interacting with the menu selections. These values define the probe connections and the calibration values to be used when the A/D readings are interpreted. The user can connect the antennas to the amplifiers in any order and must then reflect this information in the menu selections. A large part of the code in this module provides a simple means of adding, deleting or moving antenna connections among the amplifier channels while maintaining all the correct index values in the linking array 'Probe_addr(*)'. The configuration can be saved on a floppy disk (to be defined by the programmer in the main program), and the linking array can be printed for help in debugging the system. The module titled 'Probe_fill_cal' is called by the menu SUB program to initialize the calibration data files to interpret the A/D readings. A complete description of the variables used is provided at the beginning of the menu program.

3.1.2 Read_probes

This module performs the actual measurements by calling the necessary routines to read and interpret the readings. Along with the menu routine, this SUB program provides the required link with the main program to operate the probe hardware. The main program can specify that several readings will be averaged together; this average value or a single reading of each channel may be specified. The program will always read all amplifier channels that were specified in the menu and passed into the linking array. There is no provision for selecting subsets of the configuration without returning to the menu and performing the desired changes.

This module contains the subroutine that actually toggles the control lines on the GPIO such that the measurement sequence is initiated and readings taken from every A/D converter specified in the linking array. The setup and read sequence may be easily followed by reading the program in appendix I. The address of the lowest numbered amplifier channel is first set as this becomes the trigger channel for the interrupt signifying completion of the A/D conversion. The initial control signals are then established, followed by the sample/hold circuit going into the hold mode. The start conversion pulse is then generated (simultaneously to all channels), and the interrupt is enabled. The computer idles until the interrupt is detected and then proceeds to read the A/D converters sequentially. The data is masked to 12 bits and checked for an overrange bit. Corrections and calibrations are not applied at this point.

3.1.3 Probe_fill_cal

See the last two sentences of the Multiprobe_menu description.

3.1.4 Apply_probe_cal

The information returned after reading the probes is the decimal A/D output, which is proportional to the probe output voltage. When the system is reading the zero field offset values it is not necessary to translate the A/D values to field strength (see example 1 section 3.2.1). The zero field

offset corrections are exactly those A/D readings. These corrections compensate for any amplifier drift that may occur. This module is called by the main program only when actual measurements are in progress and values of field strength are required (see example 1 section 3.2.1). This module translates the A/D readings into electric field strength in volts/meter. The calibration values for amplitude are the coefficients of a two-parameter curve fitted to calibrations taken in a transverse electromagnetic (TEM) cell at 300 MHz. There are two sets of parameters for each antenna because the response of the diode extends from the square law region to the linear region, and one equation will not cover both regions adequately. The frequency response of the probe is also corrected based on calibrations of the antenna in the anechoic chamber at several frequencies. Hence this routine requires knowledge of the measurement frequency. The common point for the amplitude and frequency calibrations is 300 MHz where the amplitude detail is given. All frequency response data are then related to a given amplitude at 300 MHz. The sequence of correction is to apply the curve fit equation to the A/D reading to get an equivalent volts/meter at 300 MHz, and then make corrections for the actual frequency of operation. If the frequency is outside the limits of calibration, no modification is applied. The results of this calibration reside in the Probe_v_m(*) matrix in the order given by the Probe_addr(*) linking matrix.

3.1.5 Get_cal_value

This is a general purpose module (which may be used by any other routine) that performs a binary search along the X axis of a file and returns a Y value as a linear interpolation between data points. The Apply_probe_cal uses this routine for finding the frequency calibration value to be used from the data given. The file parameters must conform to:

- File (i,1) = X value
- File (i,2) = Y value
- Target = real number indicating the X value to search for
- Result = real number returned, the Y value at target
- Endpoint = index of the last data point (i) in the file
- Baddata = flag that is set if there is an error or the
Target is outside the x range of the file.

3.1.6 Errortrap

This is a catch-all error handling routine that is necessary for proper disk operations, etc.

3.2 Examples

3.2.1 Example 1

The following is a suggested method for interfacing a measurement program to the multiprobe system. It assumes that all COM declarations reside in the main program giving access to the variables.

Measurement program code

```
"
"
"
! Remove rf power
"
"
! Read zero field offset values
If Total_chans > 0 THEN      ! do only if probes are active
    MAT Probe_zero = (0)      ! not necessary, but good idea
    CALL Read_probes (@Gpio) ! read all active probes
    MAT Probe_zero = Probe_volts ! set values, must do
END IF
"
"
"
"
"
"
! Set up measurement environment, apply rf power
"
"
! Read the probe system
"
IF Total_chans > 0 THEN      ! do only if probes are active
    CALL Read_probes (@Gpio) ! read all active probes
    Too_hot = 0              ! begin search for overranges
    FOR P=1 to Total_chans
        Too_hot = Too_hot OR Overrange(P) ! look at each
    NEXT P
    IF Too_hot THEN          ! do something quick
        GOSUB Reduce_power
        GOTO Restart_point
    END IF
    ! not overranged, so interpret
    CALL Apply_probe_cal (Frequency)
END IF
GOSUB Print_results          ! Print results as in Probe_v_m(*)
GOSUB Save_results
"
"
"
```

At this point the results are in the matrix called Probe_v_m(*). The values are in the order dictated in the Probe_addr(*) matrix.

3.2.2 Example 2

You have selected amplifiers 5,6,7,8,10,12 with probes 2-Y, 2-Z, 3-X, 3-Y, 4-X, 4-Y respectively, then Probe_v_m(*) would contain the readings of the probes in that same order.

i.e. Probe_v_m(1) = 2-Y reading in volts/meter
Probe_v_m(2) = 2-Z
"
"
"
Probe_v_m(6) = 4-Y reading in volts/meter

Also note that Total_chans = 6 for this example.

4. SYSTEM MAINTENANCE AND TROUBLESHOOTING

4.1 Probes

Probe diode integrity and resistive lead integrity can be determined with an ohmmeter. However, care must be taken that no ohmmeter is used with a maximum output of more than 4 volts. This continuity measurement should be made at the pins on the probe connector, to keep some protective resistance line between the test meter and the probe diode. The diodes are Schottky diodes which are very subject to static damage.

A test jig that normally inserts 2 M Ω across the line must be constructed before testing. See figure 8. When the push button is pushed, the jig inserts 1 M Ω in series with each side of the line and removes the 2 megohms across the line. Trouble is indicated if there is an open circuit (infinite resistance) or short circuit (the same reading in both directions). Forward resistance should be 3 to 3 1/2 M Ω including the line and series resistor. Normal back resistance will be in the range from 7 to 20 M Ω .

If probes are found to be unserviceable, and are replaced with new probes, the calibration curve contained in the computer software should be replaced with the curve corresponding to the new probes.

4.2 Probe Amplifier Cards

The overall schematic diagram for the rf probe amplifier card is given in figure 9. More detailed schematic diagrams are given as follows:

<u>Schematic Diagram Title</u>	<u>Figure Number</u>
High-impedance amplifier	10
High-speed amplifier	11
Clock squaring and regulators	12
Address circuits	13
Analog to digital converter	14

When the system was initially delivered, all 15 probe amplifier cards were properly aligned. The most common indication of need for simple zero adjust is non-zero digital readout with zero signal input. This is generally taken care of by adjusting the zero control on the front panel.

If a more complete alignment is desired, the table in figure 15 delineates a complete alignment sequence. Figure 16 shows test point and potentiometer locations on the probe amplifier card.

If the card is suspected of not working properly, the table in figure 17 gives a list of normal test point data. Figure 18 illustrates typical system waveforms at the analog to digital converter. These may be used to assist in locating card troubles.

4.3 System and Interconnect Schematics

4.3.1 Probe Cabling Code

Figure 19 shows probe pin numbers and color codes. Figure 20 shows the 10.7 m (35 ft) rf probe amplifier cable color code and SMA cable pin assignments.

4.3.2 Backplane Interconnect Schematics

This system uses fifteen separate amplifier cards, with the outputs all connected in parallel using tri-state logic. These paralleled outputs, as well as controlling input lines, are connected through an interface to the controlling desktop computer. Figures 21 and 22 show the interconnections employed on each backplane. Each backplane is (1) capable of holding up to 8 individual probe amplifier cards, (2) capable of being connected to other backplanes via jumper cables, and (3) capable of being connected to an interface card via jumper cables. Figure 23 shows the backplane component locations. System primary power is ± 15 V, which is injected into one backplane plug, J25 or J30, and distributed by daisy chain connections to other backplanes and to the interface card. All 5.0 volt power is generated by regulators on each individual card.

4.3.3 Interface and Cabling Schematics

The interface card is mounted on the back of one of the backplane cards. It is used to interface digital signals to the computer. It also contains the 250 kHz sinewave oscillator whose signal is fed to each card, where it is squared, and then used to clock the analog to digital converters. The interface card also has alternate input ports and switches for selecting Track/Hold and Start (the A/D converter) signals from a source other than the computer. Figure 24 shows the schematic for the interface card. Figure 25 shows the interface card component locations. The table in Figure 26 shows the interface cable color code. The cables are connected to the computer.

4.4 Parts List

System parts lists are listed in the following 3 figures:

<u>Figure Number</u>	<u>Figure Title</u>
27	Probe amplifier parts list
28	Interface parts list
29	Backplane parts list

5. REFERENCES

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- [2] Bronaugh, E.; Rose, M. Jr.; Rethmann, H. Multiple isolated probe electromagnetic field measuring system. IEEE Internat. Symp. on Electromagn. Compat. 80 1538-8; Switzerland. 151; 1980.
- [3] Kanda, M.; Driver, L. A broadband electric-field probe using resistively tapered dipoles, 100 kHz - 18 GHz. IEEE Conf. EMC; 1986 September (in preparation).

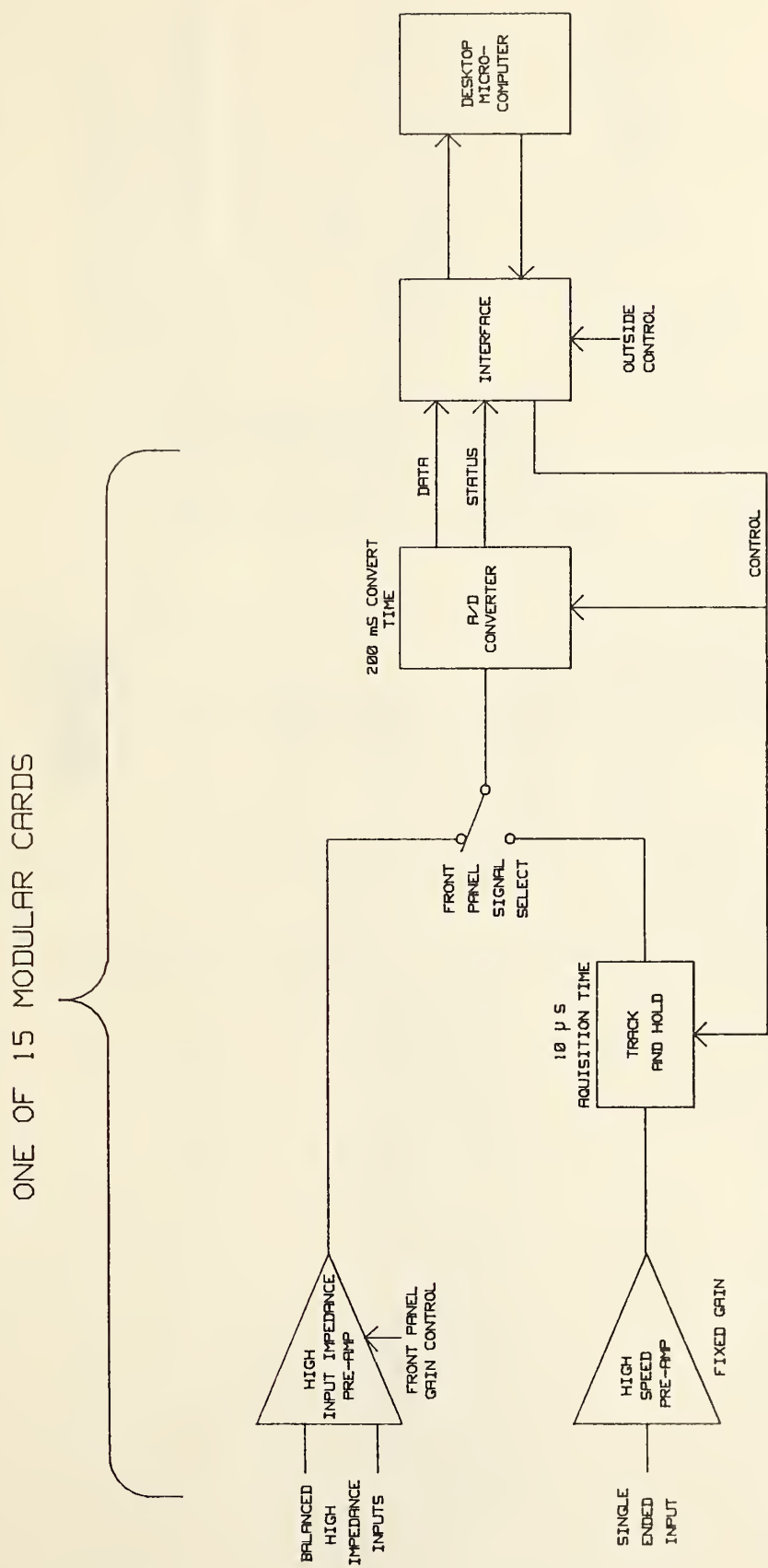


Figure 1. Block diagram of multisensor automated EM field measurement system.

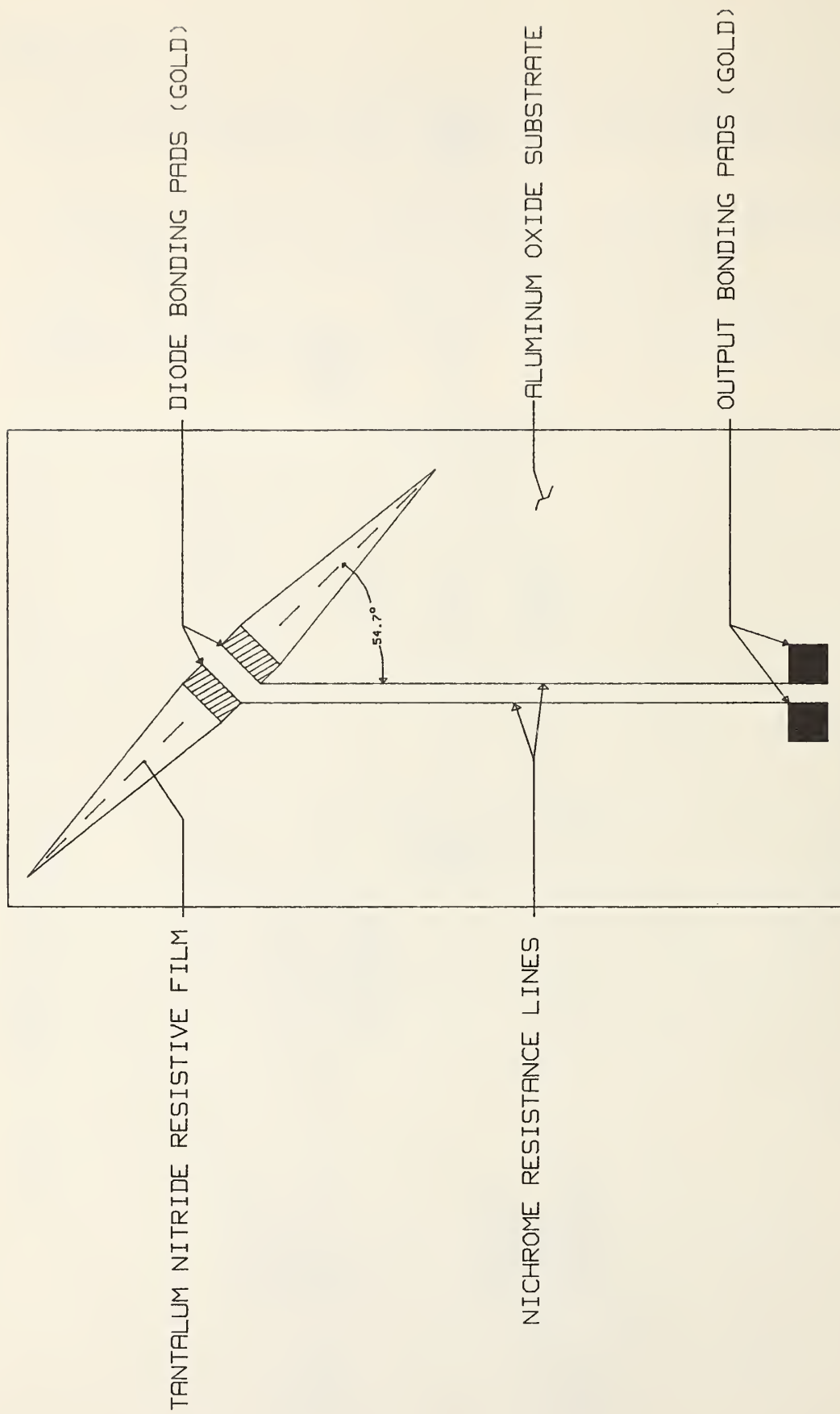
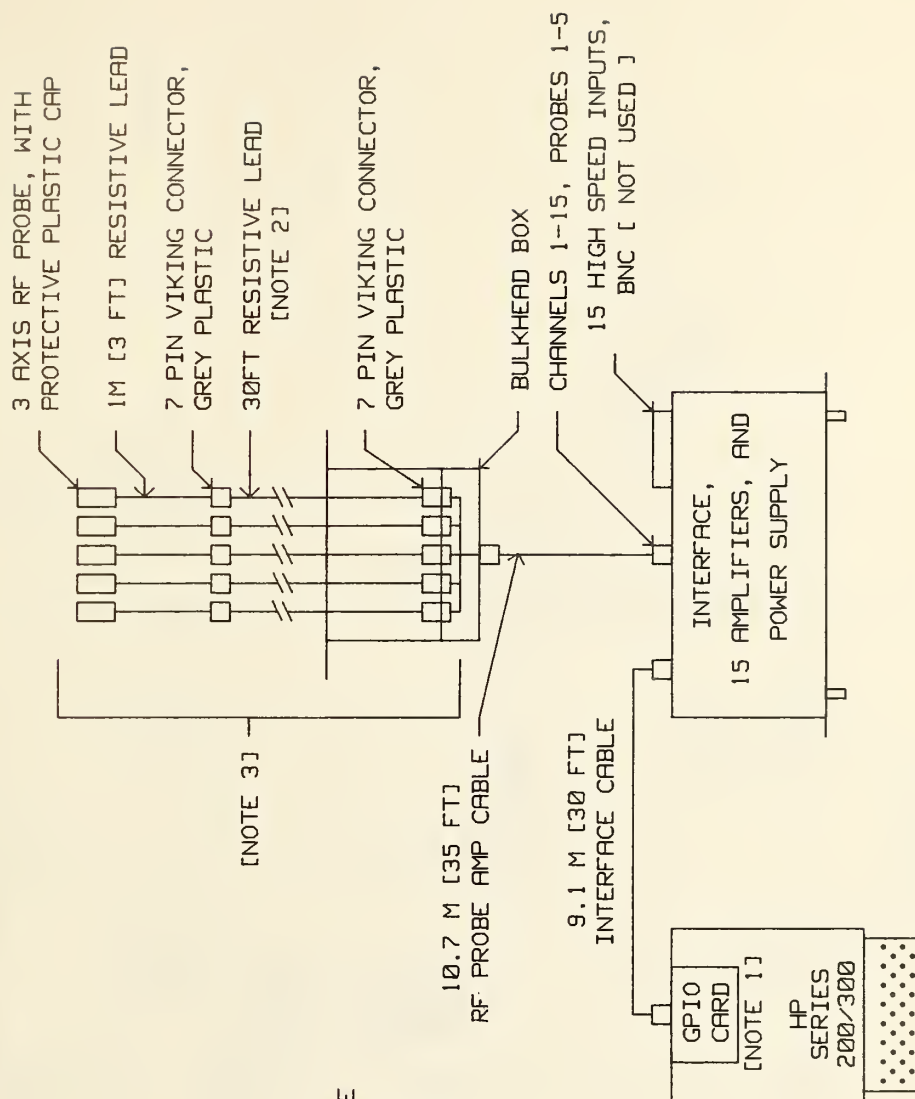


Figure 2. The 8mm thin-film dipole antenna composite diagram.



NOTES:

1. GPIO=HP 98622A .
2. EXTRA RESISTIVE LEADS TO BE COILED INSIDE BULKHEAD BOX TO REDUCE UNWANTED PICKUP.
3. THIS IS A TYPICAL SETUP; MAY HAVE CABLES SHIELDED INSIDE METALLIC DUCT, ETC.

Figure 3. Cabling diagram, rf probe system.

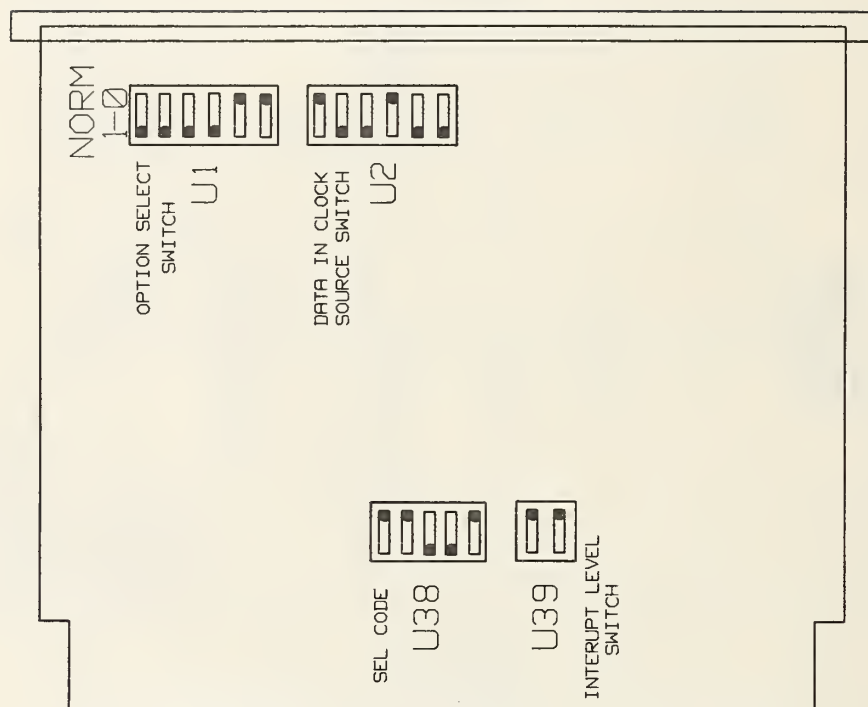


Figure 4. Setup for GPIO, HP98622A as used on HP Series 200/300.

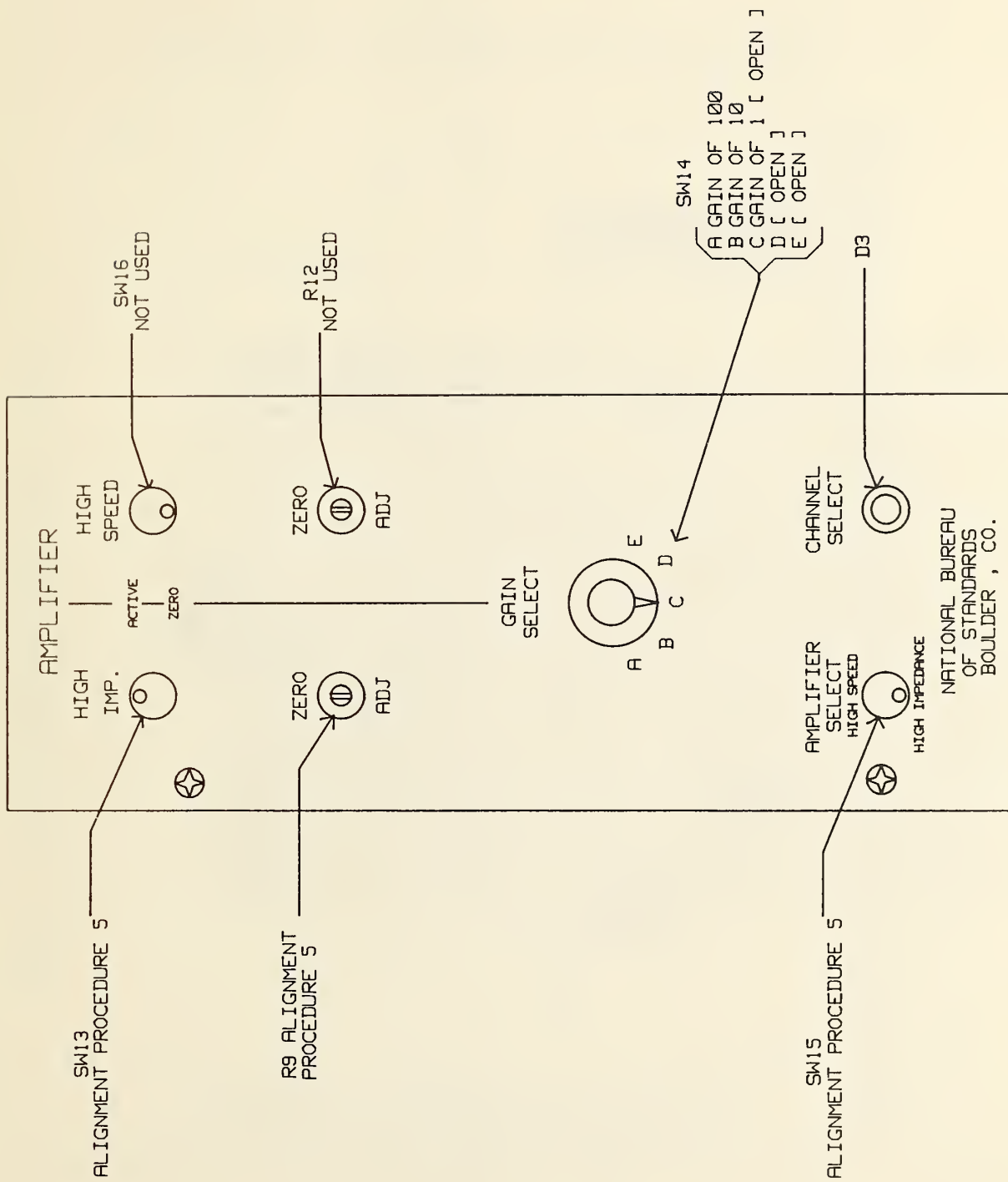


Figure 5. Front panel.

NOTE: ADDRESS SELECT SWITCHES MAY BE 10 OR 12 POSITION, WITH POSITIONS 11 AND 12 NOT USED

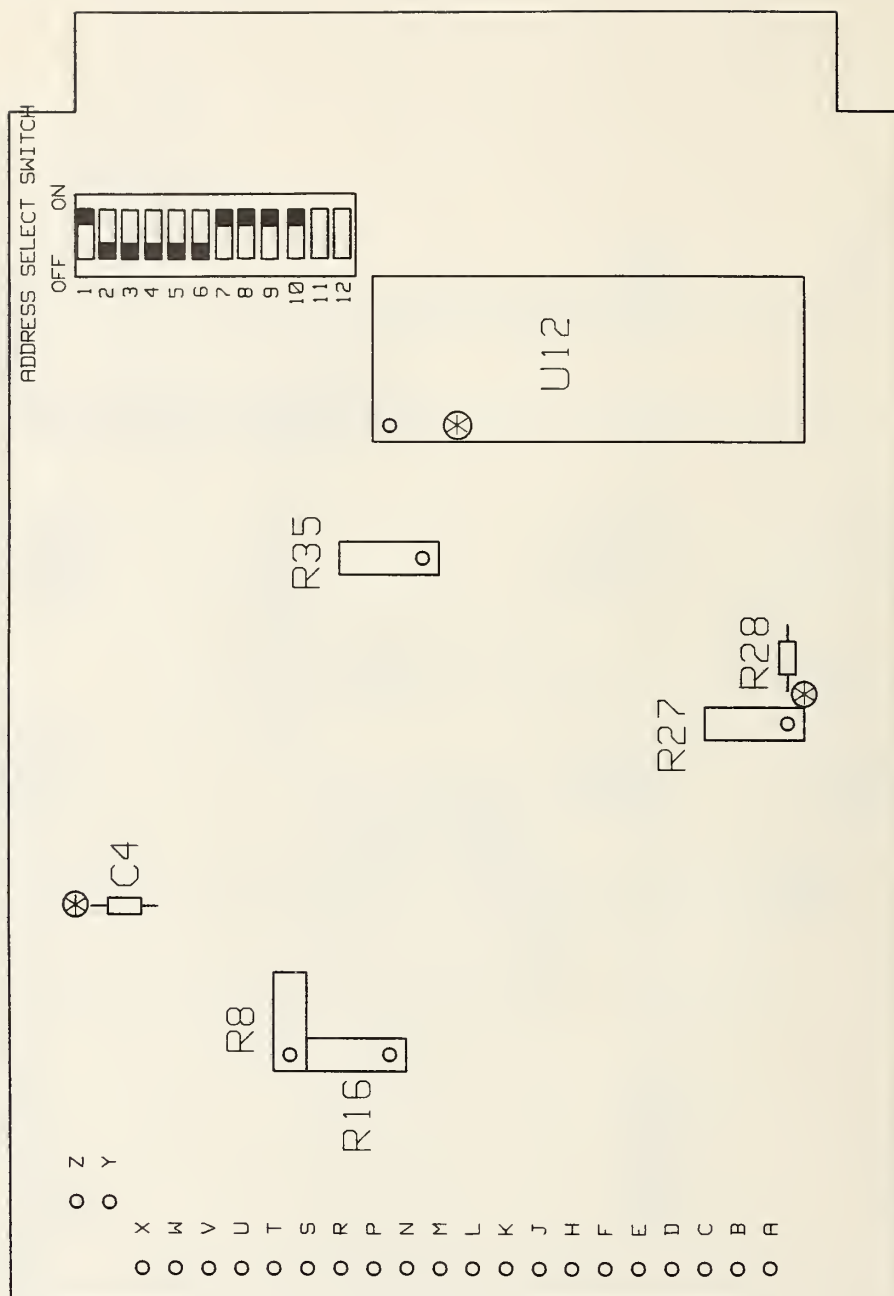


Figure 6. Address switch selection [CH 1 shown].

• = CLOSED(ON) & BLANK = OPEN(OFF)

ADDR	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
1	•						•	•	•	•
2		•				•		•	•	•
3	•	•						•	•	•
4			•			•	•		•	•
5	•		•				•		•	•
6		•	•			•			•	•
7	•	•	•						•	•
8				•		•	•	•		•
9	•			•			•	•		•
10		•		•		•		•		•
11	•	•	•	•				•		•
12			•	•		•	•			•
13	•		•	•			•			•
14		•	•	•		•				•
15	•	•	•	•						•
16					•	•	•	•	•	
17	•				•		•	•	•	
18		•			•	•		•	•	
19	•	•			•			•	•	
20			•		•	•	•		•	
21	•		•		•		•		•	
22		•	•			•			•	
23	•	•	•		•				•	
24				•	•	•	•	•		
25	•			•	•		•	•		
26		•		•	•	•		•		
27	•	•		•	•			•		
28			•	•	•	•	•			
29	•		•	•	•		•			
30		•	•	•	•	•				
31	•	•	•	•	•					

Figure 7. Address select switch coding.

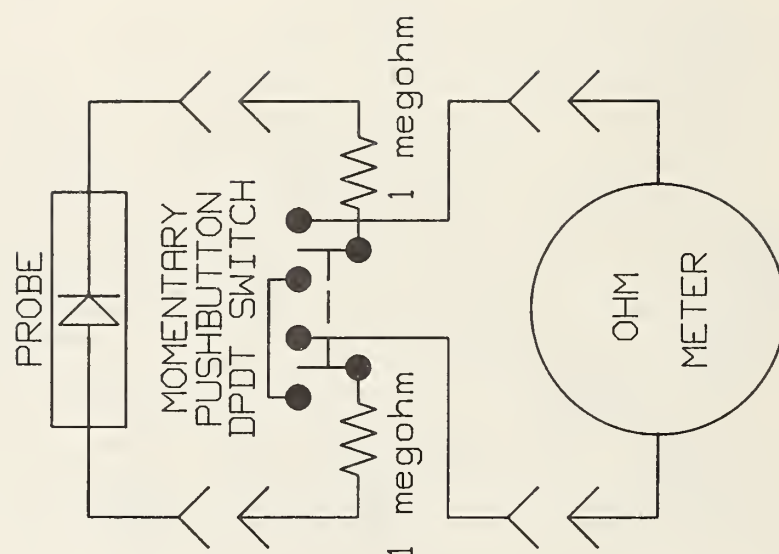


Figure 8. Probe test jig.

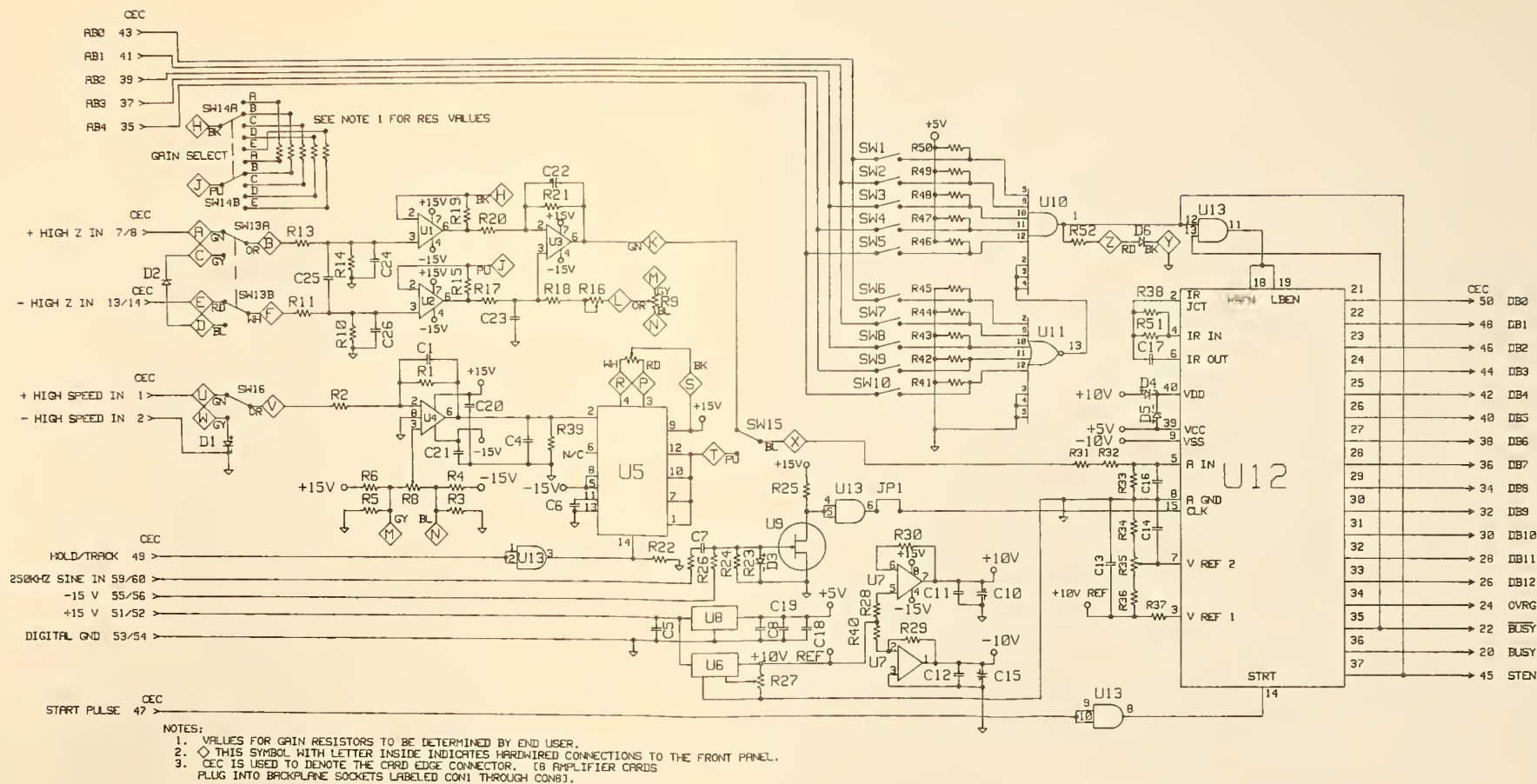
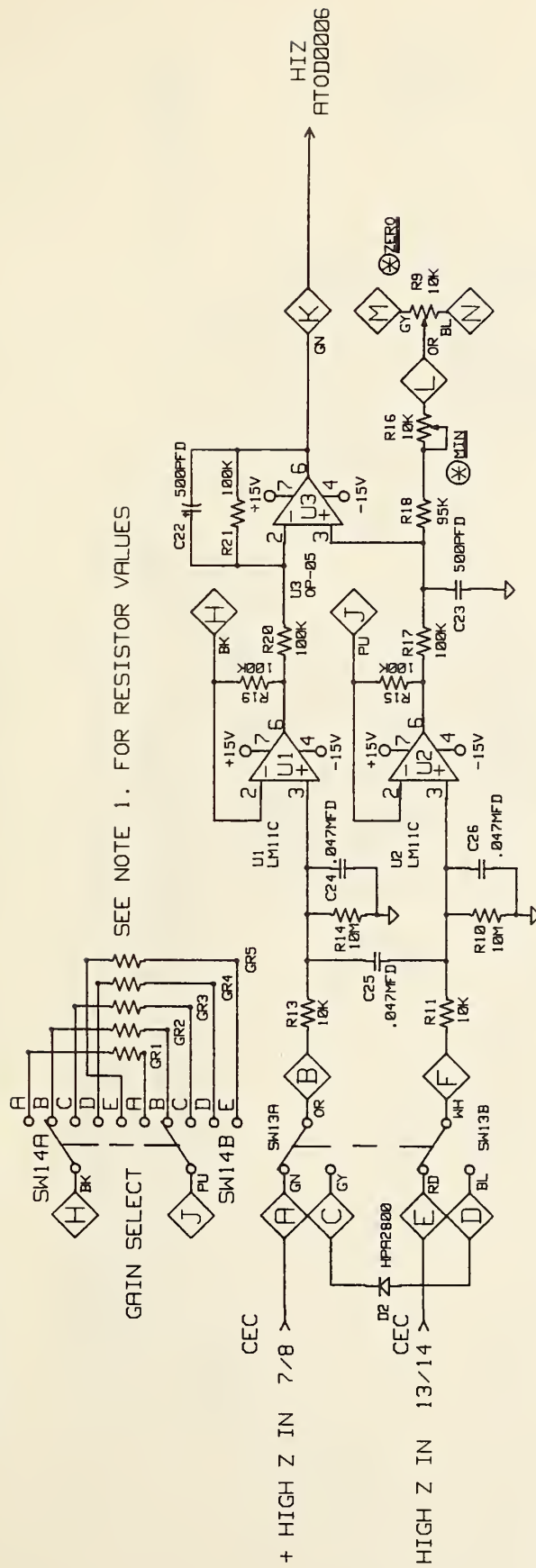


Figure 9. RF probe amplifier general schematic. See figures 10, 11, 12, 13, and 14 for more detailed schematics containing component values, etc.

DRAWING NO. HIMP0002

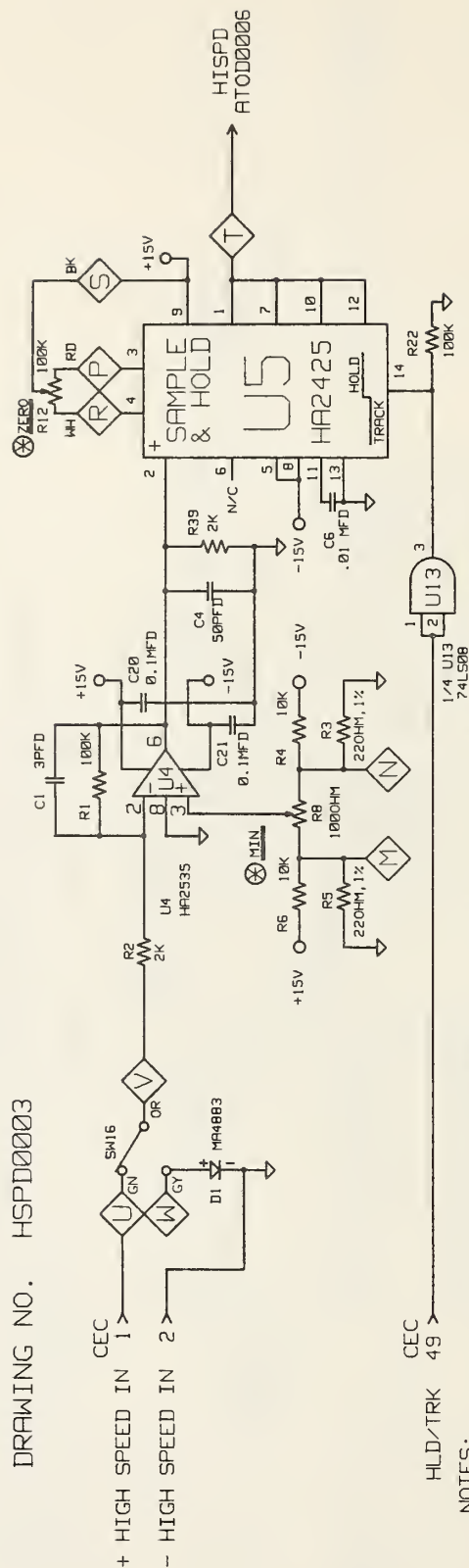


NOTES:

1. \otimes IS USED TO DENOTE ADJUSTMENT POINTS, WITH THE ADJUSTMENT IN QUESTION UNDERLINED.
2. THE VALUE OF GAIN RESISTORS [GR1 THROUGH GR5] SHOULD BE DETERMINED BY THE END USER. HOWEVER, FOR THIS SYSTEM WITH THE N. B. S. SUPPLIED PROBES, THE FOLLOWING VALUES HAVE BEEN INSTALLED:
GR1 - 2K - GAIN OF 100
GR2 - 22.1K - GAIN OF 10
GR3 - OPEN CIRCUIT - GAIN OF 1
GR4 - NOT USED
GR5 - NOT USED
3. \diamond THIS SYMBOL WITH LETTER INSIDE INDICATES HARDWIRED CONNECTIONS TO THE FRONT PANEL.
4. CEC IS USED TO DENOTE THE CARD EDGE CONNECTOR. [8 AMPLIFIER CARDS PLUG INTO BACKPLANE SOCKETS LABELED CON1 THROUGH CON8].

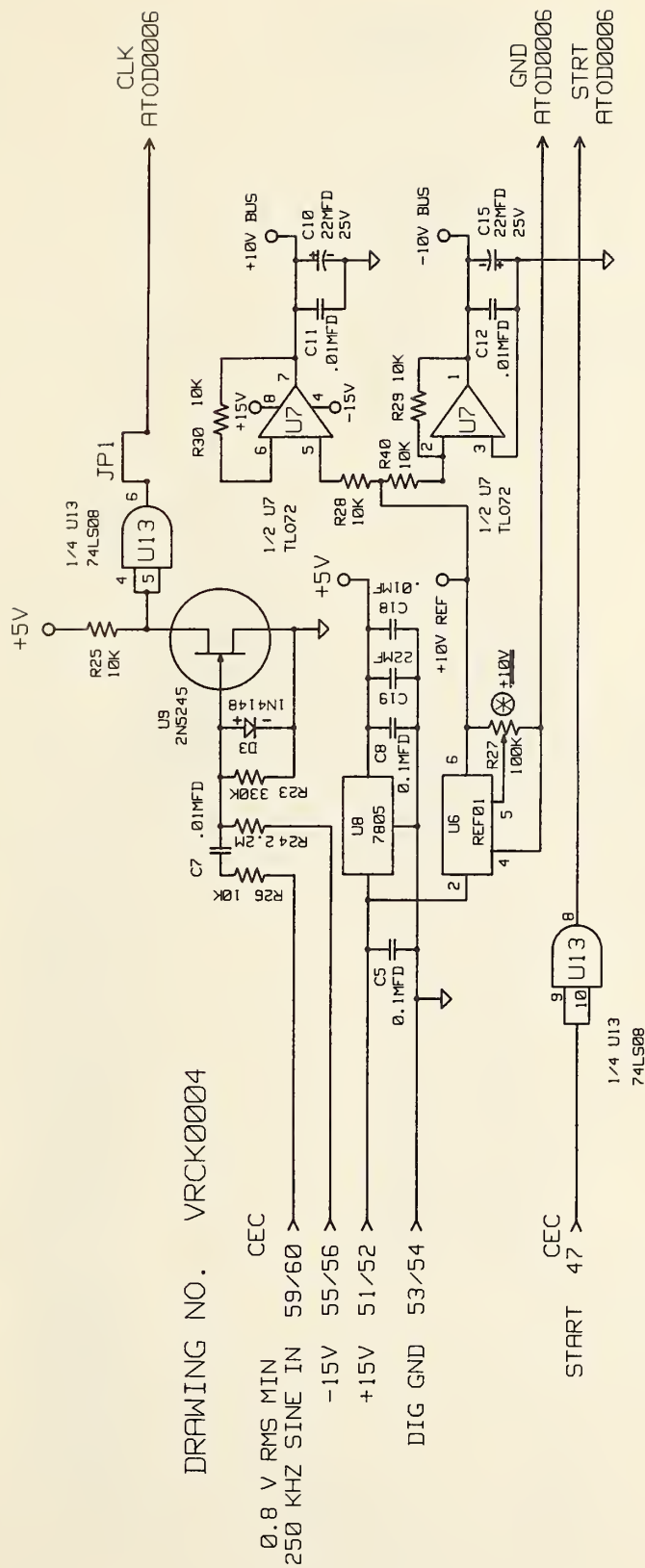
Figure 10. High impedance amplifier.

DRAWING NO. HSPD0003



- NOTES:
1. CEC IS USED TO DENOTE THE CARD EDGE CONNECTOR. [8 AMPLIFIER CARDS PLUG INTO BACKPLANE SOCKETS LABELED CON1 THROUGH CON8].
 2. \diamond THIS SYMBOL WITH LETTER INSIDE INDICATES HARDWIRED CONNECTIONS TO THE FRONT PANEL.
 3. \otimes IS USED TO DENOTE ADJUSTMENT POINTS, WITH THE ADJUSTMENT IN QUESTION UNDERLINED.

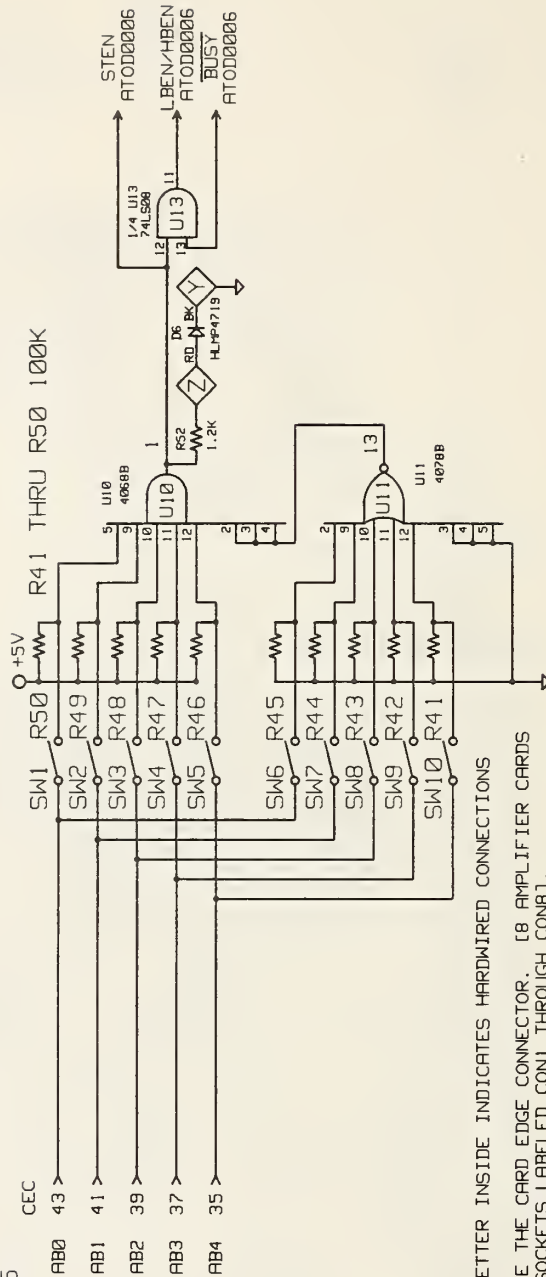
Figure 11. High speed amplifier.



NOTES:

1. IS USED TO DENOTE ADJUSTMENT POINTS, WITH THE ADJUSTMENT IN QUESTION UNDERLINED.
2. THIS SYMBOL WITH LETTER INSIDE INDICATES HARDWIRED CONNECTIONS TO THE FRONT PANEL.
3. CEC IS USED TO DENOTE THE CARD EDGD CONNECTOR. [8 AMPLIFIER CARDS PLUG INTO BACKPLANE SOCKETS LABELED CON1 THROUGH CON8].

Figure 12. Circuit diagram of clock squaring circuit, start circuit, and +/- 10 volt regulator circuit, for the probe amplifier card.



NOTES:


1.  THIS SYMBOL WITH LETTER INSIDE INDICATES HARDWIRED CONNECTIONS TO THE FRONT PANEL.
2. CEC IS USED TO DENOTE THE CARD EDGE CONNECTOR. [8 AMPLIFIER CARDS PLUG INTO BRACKPLANE SOCKETS LABELED CON1 THROUGH CON8].

Figure 13. Address selection circuits.

DRAWING NO. ATOD0006

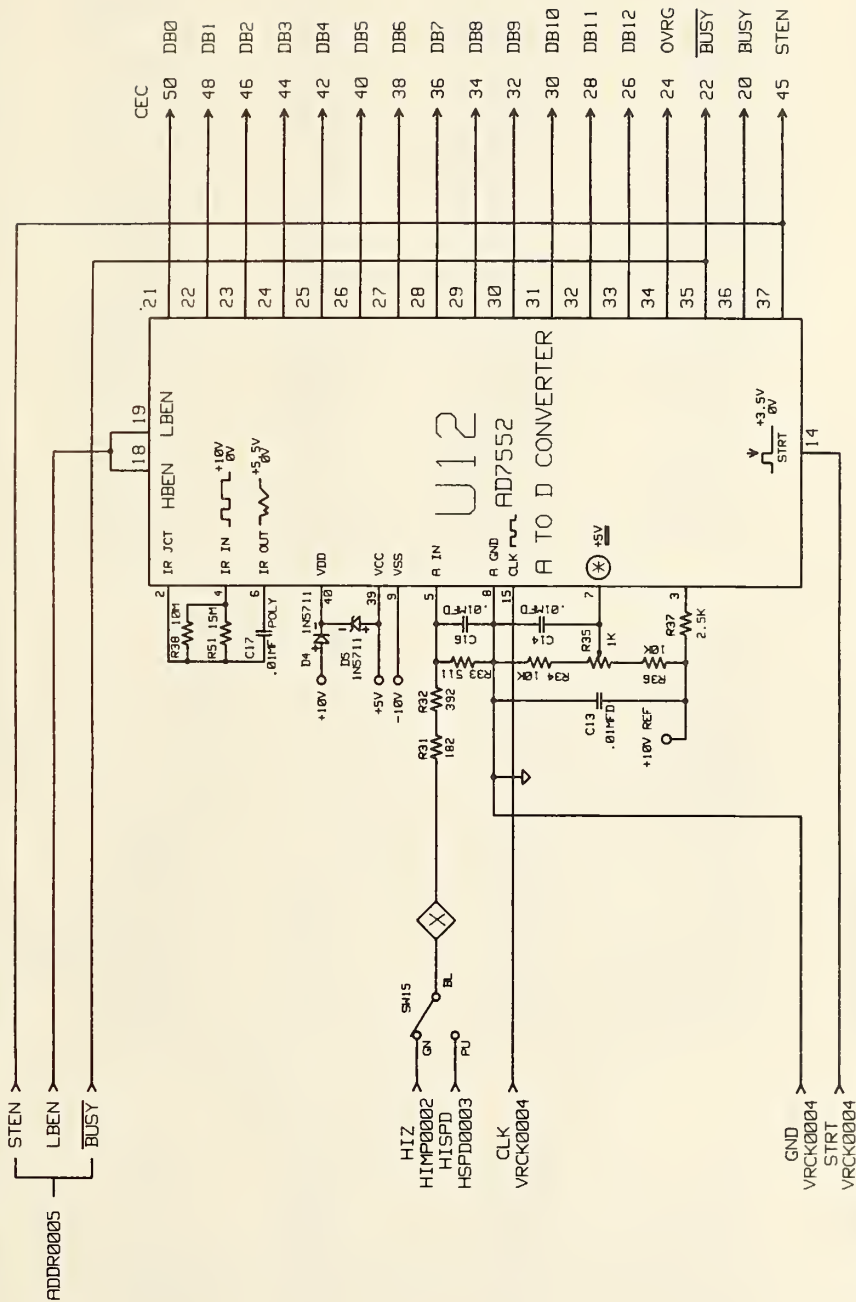


Figure 14. Analog to digital converter.

ALIGNMENT PROCEDURES

COMPONENT	TEST POINT	CONDITION
1. R8 [100 OHM POT] ON PC BOARD.	PIN 6 OF U4, JUNCTION OF R1 AND C4.	ADJUST TO 0 [0 OUTPUT AT HIGH SPEED AMP].
2. R16 [10 K POT] ON PC BOARD.	PIN 6 OF U3, CENTER OF SW 15 [AMP SELECT] ON FRONT PANEL.	TIE HIGH IMPEDANCE INPUTS TOGETHER. EXCITE THESE WITH 60 HZ, 7V PEAK TO PEAK SIGNAL. ADJUST FOR MINIMUM OUTPUT.
3. R27 [100 K POT] ON PC BOARD.	PIN 6 OF U6, JUNCTION OF R27 AND R28.	WITH AMP SELECT IN HIGH IMPEDANCE POSITION AND WITH HIGH IMPEDANCE/ZERO SWITCH IN HIGH IMPEDANCE POSITION, ADJUST TO +10.00 VOLTS.
4. R35 [1 K POT] ON PC BOARD.	PIN 7 OF U12, THE A TO D CONVERTOR.	WITH THE HIGH IMPEDANCE/ZERO SWITCH IN THE HIGH IMPEDANCE POSITION, ADJUST TO +5.00 VOLTS.
5. R9 [10 K POT] ON FRONT PANEL.	READ FROM CRT ON HP 9836 DIGITAL OUTPUT.	WITH AMP SELECT IN HIGH IMPEDANCE POSITION, AND HIGH IMPEDANCE/ZERO IN ZERO POSITION, AND WITH PROBES IN ZERO FIELD, ADJUST TO ZERO.
6. R12 [100 K POT] ON FRONT PANEL.	READ FROM CRT ON HP 9836 DIGITAL OUTPUT.	WITH AMP SELECT IN HIGH SPEED POSITION, AND HIGH SPEED/ZERO IN ZERO POSITION, AND WITH WITH PROBES IN ZERO FIELD, ADJUST TO ZERO.

Figure 15. List of alignment procedures.

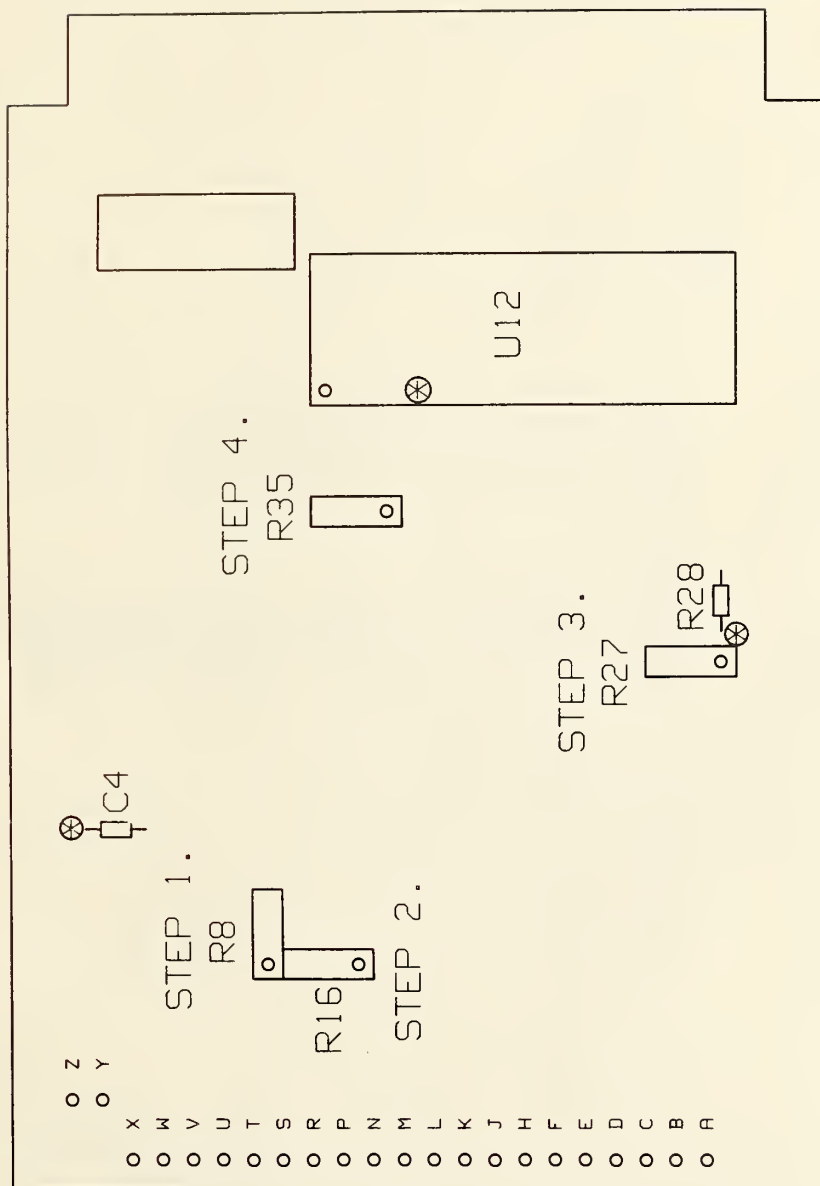


Figure 16. Probe amplifier parts locations for alignment procedures contained on figure 15. (Steps 5 and 6 adjustments are on front panel, figure 5.)

TEST POINT	OUTPUT
B	15V SINE
F	15V SINE
U1 PIN 2	15V SINE
U1 PIN 3	15V SINE
U1 PIN 6	15V SINE
U2 PIN 2	15V SINE
U2 PIN 3	15V SINE
U2 PIN 6	15V SINE
L	1 mV
M	23 mV
N	-23 mV
U3 PIN 2	15V SINE
U3 PIN 3	15V SINE
U3 PIN 6	15V SINE
R6	+15V SINE
R4	-15V SINE
JP-1	4V, 4 microSEC SQWV
U12 PIN 18	4.5V SQWV
U12 PIN 14	3.5V SQWV
U12 PIN 3	9.99V DC
U12 PIN 7	5.00V
U12 PIN 8	0
U12 PIN 5	0
U12 PIN 9	-10.03V
U12 PIN 39	5.00V
U12 PIN 40	9.66V

Figure 17. Normal test point data.

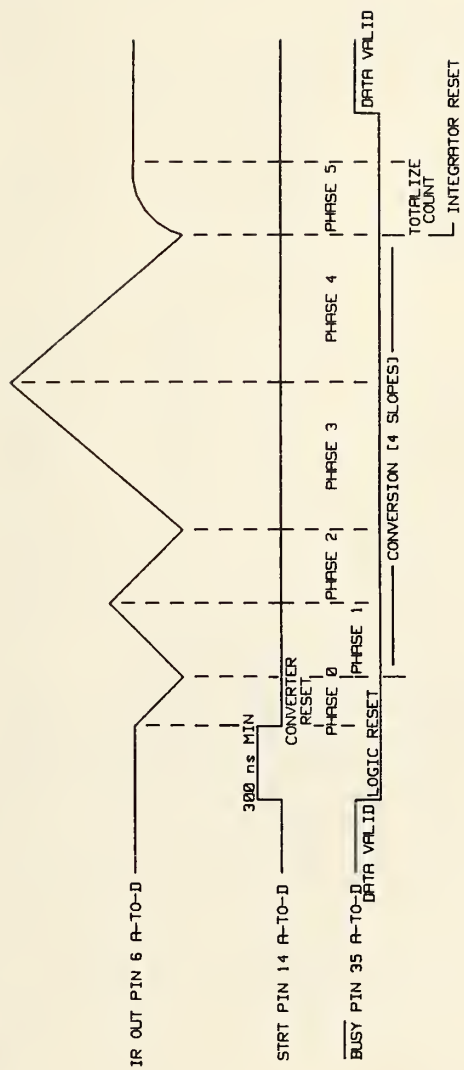
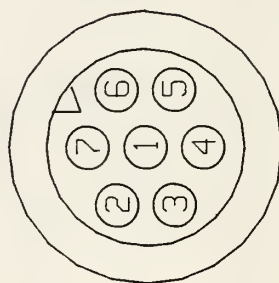


Figure 18. Typical system test waveforms.

PIN	COL	ASSIGN	50 PIN D CONN
1	GRN	GND	34, 35, 36
2	RED	X-	18
3	WHT	X+	1
4	ORG	Y-	19
5	BRN	Y+	2
6	GRY	Z-	20
7	PUR	Z+	3

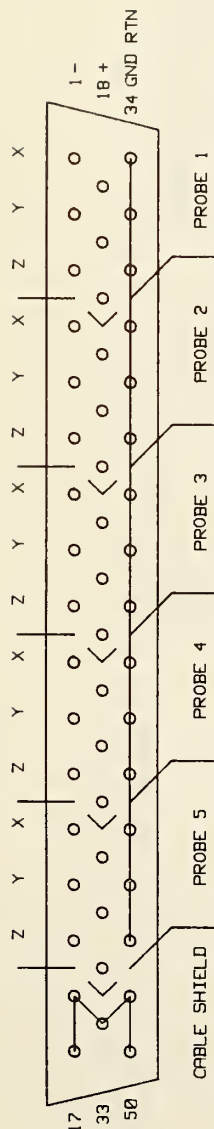


7 PIN VIKING
CONNECTOR

FOR 4 OTHER PROBES, REPEAT ABOVE COLOR CODES AS FOLLOWS:

7 PIN PIN No.	50 PIN D CONN	50 PIN D CONN	50 PIN D CONN
1	37, 38, 39	40, 41, 42	43, 44, 45
2	21	24	27
3	4	7	10
4	22	25	28
5	5	8	11
6	23	26	29
7	6	9	12
			13
			31
			14
			32
			15
			30
			46, 47, 48

Figure 19. Probe color code.



HIGH IMPEDANCE PROBE INPUTS
SMA CABLE FROM AMPLIFIERS TO 50 PIN (D) ON BACK PANEL
PIN ASSIGNMENTS

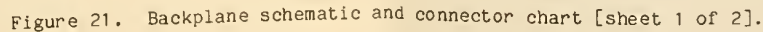
COLOR CODE FOR 10.7M(35ft) PROBE AMP CABLE, 27 PR SHIELDED CABLE WITH (D) CONNECTOR ON EACH END

- 1 BK-----18 WH 34 GN/WH
- 2 RD-----19 WH 35 WH
- 3 BN-----20 WH 36 BK/GY/WH
- 4 OR-----21 WH 37 GY/WH
- 5 YL-----22 WH 38 WH
- 6 BL-----23 WH 39 BK/OR/WH
- 7 GN-----24 WH 40 PU/WH
- 8 PU-----25 WH 41 WH
- 9 GY-----26 WH 42 BK/PU/WH
- 10 BK/WH-----27 WH 43 RD/BK/WH
- 11 RD/WH-----28 WH 44 WH
- 12 BN/WH-----29 WH 45 BK/YL/WH
- 13 OR/WH-----30 WH 46 BL/BK/WH
- 14 YL/WH-----31 WH 47 WH
- 15 BL/WH-----32 WH 48 BK/GN/WH
- 16 SHIELD 33 SHIELD 49 SHIELD
- 17 SHIELD 50 SHIELD

PINS 1-15 ARE -, PINS 16-32 ARE +, PINS 34-48 ARE GND RTN.
PINS 16, 17, 33, 49 AND 50 ARE SHIELD/GND.
EACH PAIR IN CABLE HAS 1 WHITE WIRE.
1&18, 2&19, ETC. ARE PAIRS, FOR PINS 34-48 THE PRECEDING COLOR IS
THE PAIR FOR EACH WHITE, 34&35, 37&38, ETC.

PROBES 1-15
CHANNELS 1-15

Figure 20. 10.7 meter (35 ft) rf probe amplifier cable color code and
SMA cable pin assignments.



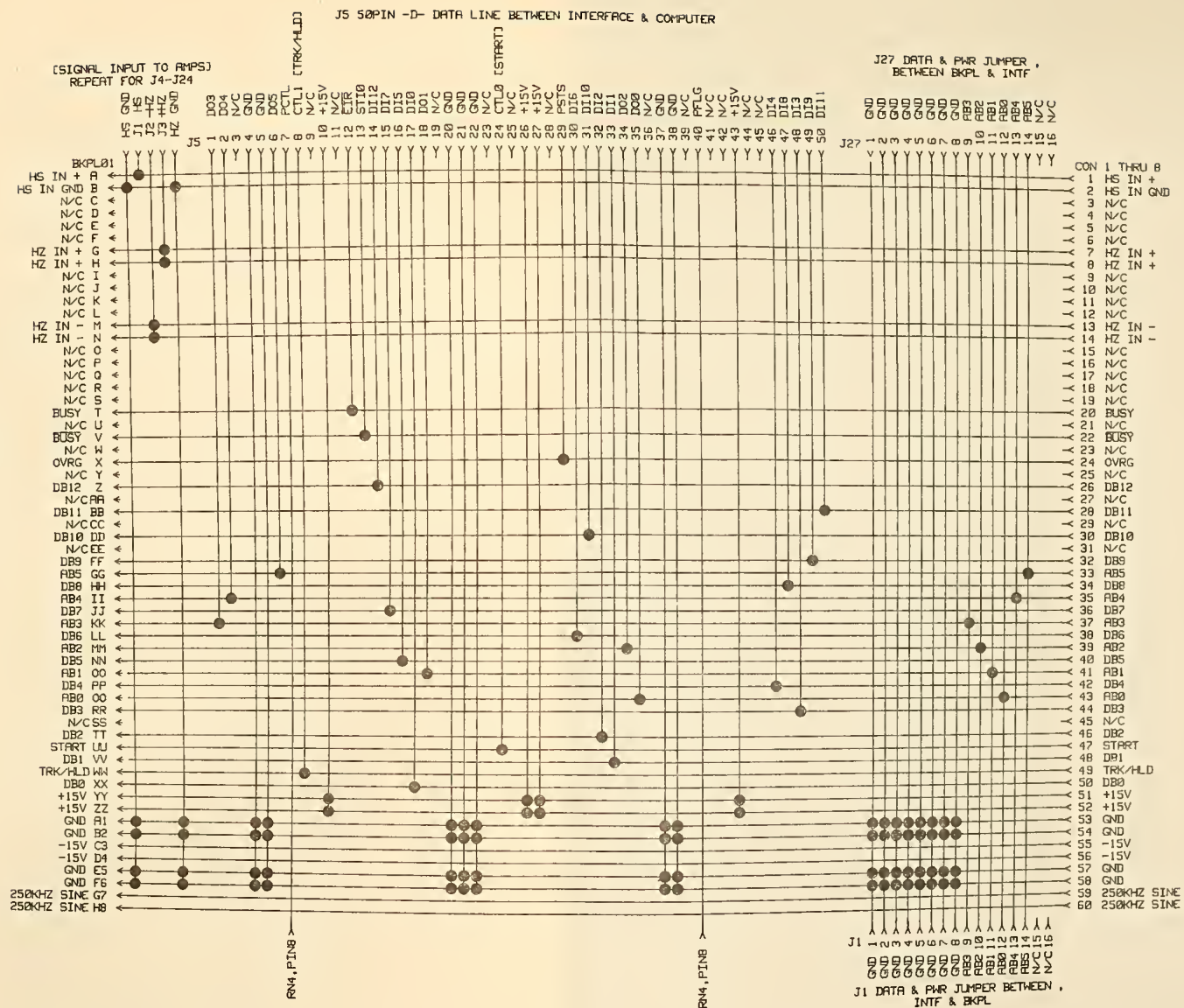


Figure 22. Backplane schematic and connector chart [sheet 2 of 2].

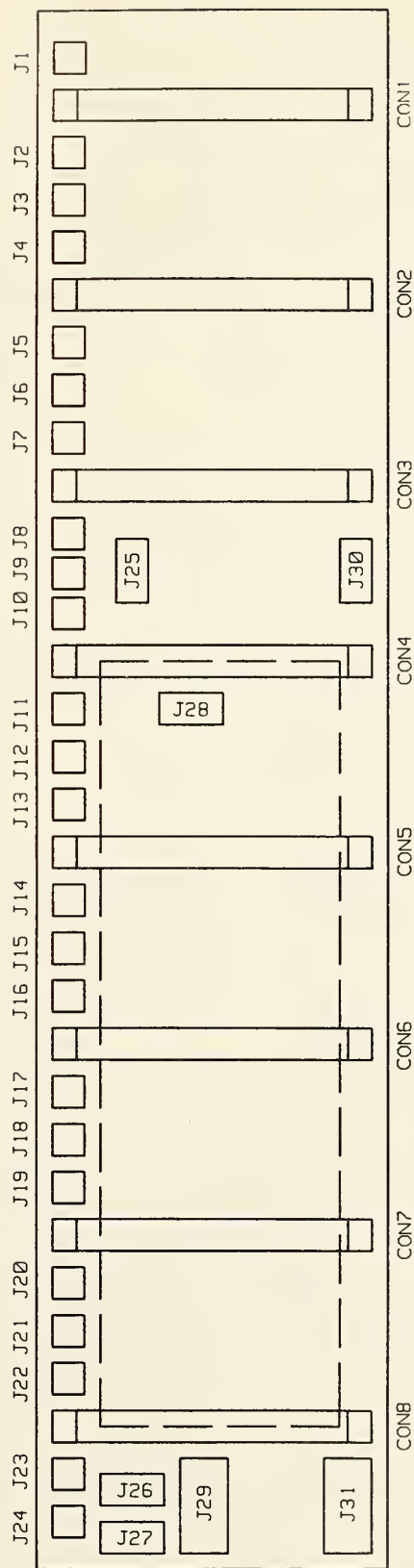


Figure 23. Backplane component locations [reference designator assignments].

DRAWING NO. INTF0007

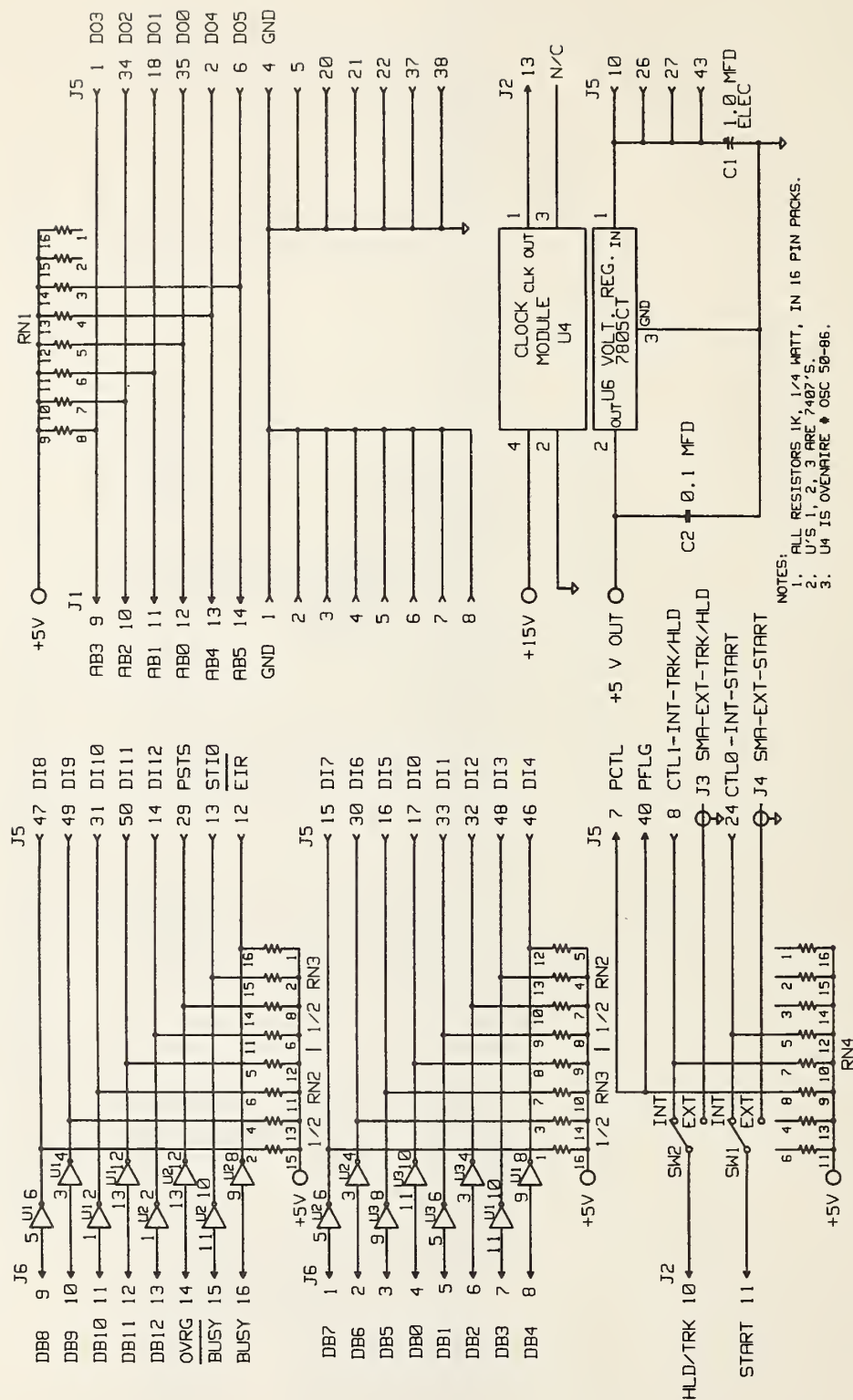


Figure 24. RF probe amplifier interface.

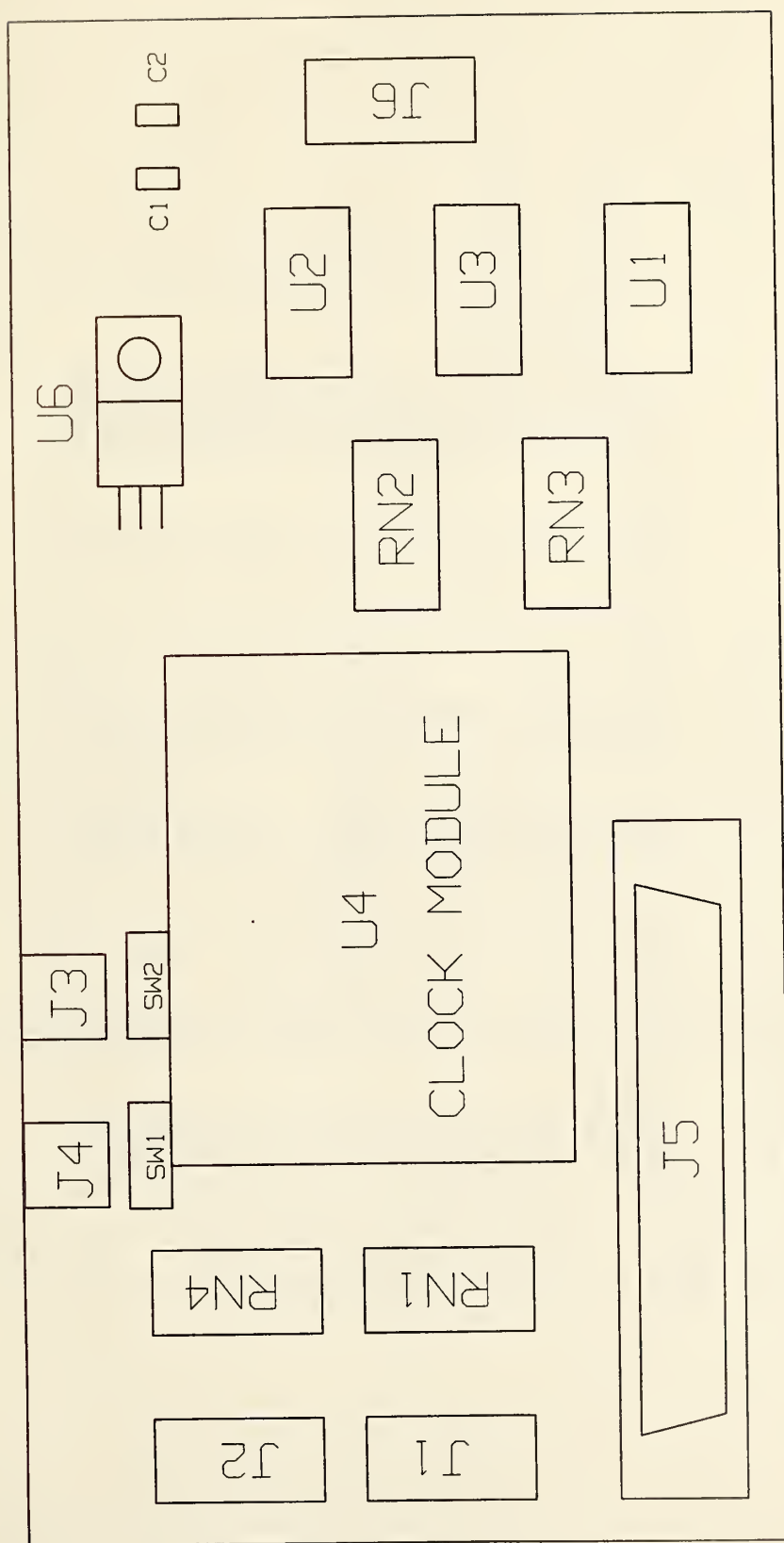


Figure 25. Interface component locations [reference designator assignments].

USE	J5-D	GPIO	COLOR	USE	J5-D	GPIO	COLOR
D03	1	14	WH/OR	*DI13	26	29	WH/RD/GN
D04	2	13	WH/YL	*DI14	27	28	WH/OR/GN
*D06	3	11	WH/PU	*D012	28	5	WH/RD/YL
GND	4	1	WH	PSTS	29	45	WH/BK/GY
GND	5	18	WH/GN/BK	DI6	30	36	BL
D05	6	12	WH/GN	DI10	31	32	WH/YL/BN
PCTL	7	19	WH/FLTJBN	DI2	32	40	RD
CTL1	8	23	WH/RD/GY	DI1	33	41	BN
*D07	9	10	WH/BL/PU	D02	34	15	WH/RD
*STI1	10	48	WH/PU/GY	D08	35	17	WH/BK
*D08	11	9	WH/BL/YL	*D013	36	4	WH/GY
EIR	12	46	WH/BN/GY	GND[INNER]	37	43	WH/YL/PU
STI0	13	47	WH/BL/BN	*GND[OUTER]	38	25	SHIELD
DI12	14	30	WH/RD/OR	*D014	39	3	WH/BK/PU
DI7	15	35	PU	PFLG	40	44	GY
DI5	16	37	GN	*D015	41	2	WH/GN/BL
DI0	17	42	BK	*I/O	42	20	WH/BL
D01	18	16	WH/BK/BN	*NOT USED	43	50	WH/BN/PU
*D09	19	8	WH/GN/GY	*PRESET	44	21	WH/RD/BK
GND	20	24	WH/BK/OR	*DI15	45	27	WH/OR/YL
GND	21	26	WH/BK/BL	DI4	46	38	YL
GND	22	49	WH/BK/YL	DI8	47	34	WH/RD/BN
*D010	23	7	WH/GN/PU	DI3	48	39	OR
CTL0	24	22	WH/RD/PU	DI9	49	33	WH/OR/BN
*D011	25	6	WH/RD/BL	DI11	50	31	WH/GN/BN

COLORS NOT USED: WH/YL/GY, WH/OR/BL, WH/OR/GN, WH/BL/GY, WH/OR/PU.
POSITIONS MARKED WITH R *, ARE N/C ON HP CABLE.

Figure 26. Interface cable color codes.

RESISTORS:		
22 OHM 5%	R3, R5	
100 OHM TRIM	R0	
182 OHM 1%	R32	
392 OHM 1%	R31	
511 OHM 1%	R33	
1K OHM TRIM	R35	
1.2K ohm 1%	R52	
2K ohm 1%	R2, R39	
2.5K ohm 1%	R37	
10K ohm 1%	R4, R6, R7, R11, R13, R25, R26,	
	R27, R29, R34, R36, R40	
10K ohm TRIM	R16	
10K ohm TRIM	R9	
PANEL MOUNT		
10K ohm 5%	R28, R30	
95K ohm 1%	R18	
100K ohm 5%	R22, R41 THROUGH R50	
100K ohm 1%	R1, R15, R17, R19, R20, R21	
100K ohm TRIM	R27	
100K ohm TRIM	R12	
PANEL MOUNT		
330K ohm 5%	R23	
2.2M ohm;1%	R24	
10M ohm 1%	R10, R14, R38	
CAPACITORS:		
500pF CERAMIC	C22, C23	
50pF MICA	C4	
3pF MICA	C1	
.01microF CERAMIC	C7, C11, C12, C13, C14, C16, C18	
.01microF POLYSTY	C6, C17	
.047microF POLYCARB	C24, C25, C26	
.1microF CERAMIC	C5, C8, C20, C21	
22microF TANT ELEC	C10, C15, C19	
DIODES:		
MA4803	D1	
HPA2800	D2	
1N4148	D3	
1N5711	D4, D5	
HLMP4719	D6	
IC'S		
LM11C	U1, U2	
OP-05	U3	
HA2535	U4	
HA2425	U5	
REF-01	U6	
TL072	U7	
MC7805C	U8	
2N5245	U9	
4068B	U10	
4078B	U11	
AD7552	U12	
74LS08	U13	
SWITCHES		
12 POS DIP	SW1 THROUGH 12	
DPDT TOGGLE	SW13	
10 POS ROT	SW14	
SPDT TOGGLE	SW15, SW16	

Figure 27. Probe amplifier parts list.

RESISTORS	
1K OHM 1/4th WATT 16 PIN DIP	RN1, RN2, RN3, RN4,
CAPACITORS	
1.0 MFD ELEC	C1
0.1 MFD	C2
IC'S	
7407	U1, U2, U3
OVENNAIRE OSC 50-86	U4
7805CT	U6
SWITCHES	
SPDT	SW1, SW2
JACKS AND CONNECTORS	
SMA FEMALE	J3, J4
16 PIN DIP	J1, J2, J6
50 PIN D MALE	J5

Figure 28. Interface parts list.

JACKS AND CONNECTORS	
J1 THROUGH J24	SMA FEMALE
J25, J26, J27, J28, J30	16 PIN DIP
J29, J31	24 PIN DIP
CON1 THROUGH CON8	50 PIN EDGE
4, 16PIN RIBBON, MALE BOTH ENDS, USED TO JUMPER INTERFACE AND BACKPLANES.	
2, 24 PIN RIBBON, MALE BOTH ENDS, USED TO JUMPER BACKPLANES.	

Figure 29. Backplane parts list [connectors].

APPENDIX

Computer Program Listing

```

100! RE-STORE "Probe_Subs"
102 ! Original: 5 May 1984 G. Koepke (303) 497-5766
104 ! Revision: 7 Nov 1985, 16:45
106 !
108 ! Second generation probe software SUB programs.
110 ! These SUBs allow any system size up to 48 probes
112 ! and for each antenna to have its' own amplitude and
114 ! frequency calibration data.
116 !
118 ! Currently set to 15 channels for the NSWC system.
120 !
122 OPTION BASE 1
124 DEG
126 PRINTER IS CRT
128 !
130 Dim_variables: !
132 !
134 COM /Probe_system/ INTEGER Sys_size,Total_chans,Probe_addr(15,3)
136 COM /Probe_system/ INTEGER Top_probe,Fcal_pts,Pr_avgs
138 COM /Probe_system/ INTEGER Probe_volts(15),Overrange(15)
140 COM /Probe_system/ INTEGER Probe_zero(15),REAL Probe_v_m(15)
142 COM /Probe_system/ REAL Amplitude_cal(5,3,5),Freq_cal(5,3,6,2)
144 COM /Probe_system/ REAL Readtime(15),Freq_crib(6,2)
146 COM /Interrupts/ INTEGER Intr_prty
148 COM /Bugs/ INTEGER Bug1,Bug2,Bug3,Printer
150 COM /Files/ Sourcedisk$(20),Outdisk$(20),Filename$(80)
152 !
154 INTEGER Local_prty,P_sams,P
156 REAL Frequency
158 Intr_prty=5
160 Local_prty=5
162 Printer=701
164 Sourcedisk$=":INTERNAL,4,0"
166 Outdisk$=":INTERNAL,4,1" ! ":HP9133,700,0"
168 Bugs: !
170 Bug1=0
172 Bug2=1
174 Bug3=0
176 !
178 CALL Multiprobe_menu ! Set up the 15 probe system.
180 P_sams=3 ! Read Multiprobe 3 times and average.
182 MAT Probe_volts= (100) ! dummy data actual sequence below
184 MAT Overrange= (0) ! dummy data
186 MAT Probe_zero= (0) ! dummy data
188 Frequency=300 ! dummy data
190 CALL Apply_probe_cal(Frequency) ! Amplitude & frequency correction
192 STOP ! END test subs.....suggested sequence follows
194 !
196 ! Fill Probe_volts(*) using Probe_addr(*) and Total_chans
198 !
200 ! IF Total_chans>0 THEN ! ZERO field offset reading (probe zero)
202 ! MAT Probe_zero= (0)
204 ! CALL Read_probes(@Gpio)
206 ! MAT Probe_zero= Probe_volts
208 ! END IF
210 ! IF Total_chans>0 THEN ! Field applied, now read probes
212 ! CALL Read_probes(@Gpio)
214 ! Too_hot=0
216 ! FOR P=1 TO Total_chans
218 ! Too_hot=Too_hot OR Overrange(P) ! Test for overrange

```

```

220 !     NEXT P
222 !     IF Too_hot THEN
224 !         GOSUB Reduce_power
226 !         GOTO Restart_point
228 !     END IF
230 !     CALL Apply_probe_cal(Frequency)! Amplitude & frequency correction
232 ! END IF
234 END
236 !
238 ! *****
240 !
242 SUB Multiprobe_menu
244 Multiprobe_menu: !
246 ! Provide a means of controlling the multi-probe system.
248 ! The menu allows one to select the Amplifier channel and
250 ! the probe connected to it.
252 ! This information will be used to draw calibration data from
254 ! the calibration matrix.
256 ! .....
258 ! ----- Variable and matrix index Definitions -----
260 ! .....
262 !
264 ! Sys_size => Number of amplifiers in the system, this defines
266 ! menu limits so that one software package serves
268 ! systems of different sizes. (Sys_size = *)
270 !
272 ! Top_probe => The highest index for any probe in the system [<99]
274 ! This index ties the calibration data to the antenna.
276 ! Whatever number of probes are used, the index numbers
278 ! must be sequential and tied to the calibration matrix
280 ! with values entered for them.
282 !
284 ! Total_chans => Number of amplifiers currently enabled by menu.
286 !
288 ! Probe_addr(*,3) => (*,1) = Amplifier channel
290 !                   (*,2) = Probe index number up to Top_probe
292 !                   (*,3) = Probe channel 1=X, 2=Y, 3=Z, 4=Single
294 !                   (4 is the same as 1 in drawing out the
296 !                   calibration data)
298 !
300 ! Pr_avgs => The number of readings to be averaged together.
302 !
304 ! Probe_volts(*) => Actual reading of A/D output.
306 !
308 ! Overrange(*) => Overrange flag for each channel
310 !
312 ! Readtime(*) => Conversion and read time of each channel.
314 !
316 ! Probe_zero(*) => Zero field offset reading
318 !
320 ! Probe_v_m(*) => Final reading in Volts/meter.
322 !
324 ! Amplitude_cal(# probe,channel[1-3],curvefit coef[1-5]) =>
326 ! Amplitude calibration data: # probe = Top_probe
328 !                               channels 1=X or S, 2=Y, 3=Z
330 !                               curvefit coef 1= a1 (low)
332 !                                               2= b1 (low)
334 !                                               3= a2 (high)
336 !                                               4= b2 (high)
338 !                                               5= low-high crossing

```



```

340      !
342      ! Freq_cal(# probe,channel[1-3],CAL_pt,freq [1] or dB [2]) =>
344      ! Frequency calibration data: # probe and channels as above
346      !                               CAL_pt= up to Fcal_pts as below
348      !                               freq or dB;    1= frequency of cal
350      !                               2= value dB at 1
352      ! Fcal_pts => Total number of calibration points in frequency
354      !
356      ! .....
358      !
360      System_defns: !
362      ! xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
364      ! ..... MULTI-PROBE SYSTEM DEFINITIONS .....
366      ! xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
368      !
370      OPTION BASE 1
372      COM /Probe_system/ INTEGER Sys_size,Total_chans,Probe_addr(15,3)
374      COM /Probe_system/ INTEGER Top_probe,Fcal_pts,Pr_avgs
376      COM /Probe_system/ INTEGER Probe_volts(15),Overrange(15)
378      COM /Probe_system/ INTEGER Probe_zero(15),REAL Probe_v_m(15)
380      COM /Probe_system/ REAL Amplitude_cal(5,3,5),Freq_cal(5,3,6,2)
382      COM /Probe_system/ REAL Readtime(15),Freq_crib(6,2)
384      !
386      Sys_size=15      ! SYSTEM SIZE set here!!!
388      Top_probe=5      ! Set all matrix dimensions accordingly in
390      Fcal_pts=6        ! above COM statements.
392      Pr_avgs=1        ! return single sample per reading.
394      ! NOTE: Allow for three channels for every probe
396      !           even if there is a single channel.
398      !           You may, however, group several single
400      !           channel devices together under one index
402      !           number. (i.e. call first #25X, second one
404      !           #25Y, etc.). All probes in the system must
406      !           be numbered sequentially.
408      !           The calibration values are entered in the
410      !           sub called Probe_fill_call.
412      !
414      ! xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
416      !
418      COM /Interrupts/ INTEGER Intr_prt
420      COM /Bugs/ INTEGER Bug1,Bug2,Bug3,Printer
422      COM /Files/ Sourcedisk$(20),Outdisk$(20),Filename$(80)
424      INTEGER I,J,K,Local_prt,Knobcnt_x,Knobcnt_y,Selectpoint
426      INTEGER Duplicated,Test_size,Poffset,Column1,Column2,Column3
428      INTEGER Interrupted
430      DIM Marker$(8),Test$(160)
432      Local_prt=Intr_prt
434      DISP CHR$(128)
436      IF Bug1 THEN
438          PRINTER IS Printer
440          PRINT TIME$(TIMEDATE); "***** ENTER Multiprobe_menu *****"
442      END IF
444      PRINTER IS CRT
446      GOSUB Print_bckgnd      !Print the heading and the amplifier channels.
448      GOSUB Select_configur  !Select source of probe system configure.
450      !From disk, none or all probes.
452      GOSUB Configure_probe !Select the amplifier and probe combination.
454      IF Bug1 THEN
456          PRINTER IS Printer
458          PRINT TIME$(TIMEDATE); "***** EXIT Multiprobe_menu *****"

```

```

460         PRINTER IS CRT
462     END IF
464     OUTPUT 2 USING "#,K";"K"    !Clear screen.
466     CALL Probe_fill_cal      ! Fill Amplitude_cal(*) and Freq_cal(*)
468     SUBEXIT
470     !
472     ! //////////////////////////////////////
474     !
476 Select_configur:OFF KEY
478     DISP " SELECT SOURCE OF MULTI-PROBE CONFIGURATION "
480     ON KEY 0 LABEL "NO PROBES",Local_prty GOTO Noprobes
482     ON KEY 1 LABEL "ALL PROBES",Local_prty GOTO Allprobes
484     ON KEY 5 LABEL "CUR SETUP",Local_prty GOTO Config_selected
486     ON KEY 2 LABEL "FROM DISK",Local_prty GOTO Diskinfo
488     LOOP
490     END LOOP
492 Diskinfo:GOSUB Read_probe_disk
494     GOTO Config_selected
496 Allprobes:GOSUB Fill_addresses
498     GOTO Config_selected
500 Noprobes:Total_chans=0
502     MAT Probe_addr= (0)
504 Config_selected:OFF KEY
506     DISP CHR$(12)
508     FOR I=Total_chans+1 TO Sys_size
510         Probe_addr(I,1)=99
512         Probe_addr(I,2)=0
514         Probe_addr(I,3)=0
516     NEXT I
518     RETURN
520     !
522     ! //////////////////////////////////////
524     !
526 Configure_probe: !
528     GOSUB Print_probeaddr
530     Marker$="==>"&RPT$(CHR$(8),4)
532     Knobcnt_x=0    !move up and down columns
534     Knobcnt_y=0    !move between rows.
536     Interrupted=1
538     Selectpoint=1
540     PRINT TABXY(1,Selectpoint+2);CHR$(128);Marker$;
542     LOOP
544         IF Interrupted THEN
546             ON KNOB .05 GOSUB Movepointer
548             ON KEY 5 LABEL "ALL DONE",Local_prty GOTO Allconfigured
550             ON KEY 0 LABEL "CONFIG MENU",Local_prty GOSUB Sourcemenue
552             ON KEY 1 LABEL "CHANGE PROBE",Local_prty GOSUB Changeprobe
554             ON KEY 2 LABEL "ADD PROBE",Local_prty GOSUB Addprobe
556             ON KEY 3 LABEL "READ DISK FILE",Local_prty GOSUB Read_disk
558             ON KEY 4 LABEL "SAVE ON DISK",Local_prty GOSUB Saveondisk
560             ON KEY 7 LABEL "DELETE PROBE",Local_prty GOSUB Deleteprobe
562             ON KEY 9 LABEL "LIST ADDRS",Local_prty GOSUB List_addresses
564             DISP CHR$(129);" USE (shift) KNOB TO SELECT AMPLIFIER ";
566             DISP " and SOFTKEY TO SELECT ACTION. "
568             Interrupted=0
570         END IF
572     END LOOP
574 Allconfigured:OFF KEY
576     OFF KNOB
578     DISP CHR$(12)    !Turn off display enhancements

```

```

580      PRINT CHR$(128)
582      RETURN
584      !
586      ! ///////////////////////////////////////////////////////////////////
588      !
590 Sourcemenu: !
592      Interrupted=1
594      Local_prty=Local_prty+1
596      GOSUB Select_configur
598      GOSUB Print_probeaddr
600      GOSUB Reset_pointer
602      Local_prty=Local_prty-1
604      RETURN
606      !
608      ! ///////////////////////////////////////////////////////////////////
610      !
612 Movepointer: ! Move selector on menu
614      Knobcnt_x=Knobcnt_x+KNOBX
616      Knobcnt_y=Knobcnt_y+KNOBY
618      IF ABS(Knobcnt_x)<5 AND ABS(Knobcnt_y)<10 THEN RETURN
620      IF ABS(Knobcnt_x)>=5 THEN
622          Selectpoint=Selectpoint+SGN(Knobcnt_x)
624          IF Selectpoint>Sys_size THEN Selectpoint=1
626          IF Selectpoint<1 THEN Selectpoint=Sys_size
628      END IF
630      IF ABS(Knobcnt_y)>=10 THEN
632          SELECT Selectpoint
634              CASE 1 TO Column1
636                  IF SGN(Knobcnt_y)>0 THEN
638                      IF Column2=Column1 OR Selectpoint<>Column1 THEN
640                          Selectpoint=Selectpoint+Column1
642                      END IF
644                  END IF
646                  CASE Column1+1 TO Column1+Column2
648                      IF SGN(Knobcnt_y)>0 THEN
650                          IF Column3=Column2 OR Selectpoint<>Column1+Column2 THEN
652                              Selectpoint=Selectpoint+Column2
654                          END IF
656                      END IF
658                      IF SGN(Knobcnt_y)<0 THEN Selectpoint=Selectpoint-Column1
660                  CASE Column1+Column2+1 TO Sys_size
662                      IF SGN(Knobcnt_y)<0 THEN Selectpoint=Selectpoint-Column2
664                  END SELECT
666      END IF
668      Knobcnt_x=0
670      Knobcnt_y=0
672      OUTPUT 2;CHR$(255)&CHR$(84);    !Home the screen
674      PRINT CHR$(128);
676      PRINT "      ";
678      GOSUB Reset_pointer
680      PRINT Marker$;
682      RETURN
684      !
686      ! ///////////////////////////////////////////////////////////////////
688      !
690 Reset_pointer: !
692      PRINT TABXY(1,1);
694      SELECT Selectpoint
696          CASE 1 TO Column1
698              PRINT TABXY(1,Selectpoint+2);

```



```

700     CASE Column1+1 TO Column2+Column1
702         PRINT TABXY(31,Selectpoint-Column1+2);
704     CASE Column1+Column2+1 TO Sys_size
706         PRINT TABXY(61,Selectpoint-Column1-Column2+2);
708     END SELECT
710     RETURN
712     !
714     ! //////////////////////////////////////
716     !
718 Position_pen:      ! Set the pen to the probe # column.
720     PRINT TABXY(1,1);CHR$(128);
722     SELECT Selectpoint
724     CASE 1 TO Column1
726         PRINT TABXY(13,Selectpoint+2);RPT$(" ",8);
728         PRINT TABXY(13,Selectpoint+2);
730     CASE Column1+1 TO Column1+Column2
732         PRINT TABXY(43,Selectpoint-Column1+2);RPT$(" ",8)
734         PRINT TABXY(43,Selectpoint-Column1+2);
736     CASE Column1+Column2+1 TO Sys_size
738         PRINT TABXY(73,Selectpoint-Column1-Column2+2);RPT$(" ",8);
740         PRINT TABXY(73,Selectpoint-Column1-Column2+2);
742     END SELECT
744     RETURN
746     !
748     ! //////////////////////////////////////
750     !
752 Fill_addresses: ! Put all probes into the ADDR matrix.
754     K=1
756     MAT Probe_addr= (0)
758     Total_chans=MIN(Sys_size,Top_probe*3)
760     FOR I=1 TO Sys_size-2 STEP 3
762         FOR J=1 TO 3
764             IF I+J-1<=Top_probe*3 THEN
766                 Probe_addr(I+J-1,1)=I+J-1
768                 Probe_addr(I+J-1,2)=K
770                 Probe_addr(I+J-1,3)=J
772             ELSE
774                 Probe_addr(I+J-1,1)=99
776                 Probe_addr(I+J-1,2)=0
778                 Probe_addr(I+J-1,3)=0
780             END IF
782         NEXT J
784         K=K+1
786     NEXT I
788     RETURN
790     !
792     ! //////////////////////////////////////
794     !
796 Print_bckgnd: !
798     ! Set up the menu limits and column length.
800     Column1=(Sys_size DIV 3)+MIN(Sys_size MODULO 3,1)
802     Column2=(Sys_size DIV 3)+MAX(MIN((Sys_size MODULO 3)-1,1),0)
804     Column3=Sys_size DIV 3
806     !
808     OUTPUT 2 USING "K,#";"KT"
810     PRINT TABXY(1,1);CHR$(132);RPT$(">",26);
812     PRINT " MULTI-PROBE CONFIGURATION ";RPT$("<",26)
814     PRINT TABXY(1,2);CHR$(129);" Amplifier-Probe # "
816     PRINT TABXY(31,2);" Amplifier-Probe # "
818     PRINT TABXY(61,2);" Amplifier-Probe # "

```

```

820     PRINT CHR$(128)
822     FOR I=1 TO Column1
824         PRINT TABXY(5,I+2);
826         PRINT USING "MDD,#";I
828         PRINT " ----"
830     NEXT I
832     FOR I=1 TO Column2
834         PRINT TABXY(35,I+2);
836         PRINT USING "MDD,#";I+Column1
838         PRINT " ----"
840     NEXT I
842     FOR I=1 TO Column3
844         PRINT TABXY(65,I+2);
846         PRINT USING "MDD,#";I+Column1+Column2
848         PRINT " ----"
850     NEXT I
852     RETURN
854     !
856     ! //////////////////////////////////////
858     !
860 Print_probeaddr: !
862     PRINT TABXY(1,1);CHR$(128);
864     J=1
866     FOR I=1 TO Column1
868         PRINT TABXY(13,I+2);RPT$(" ",8);
870         PRINT TABXY(13,I+2);
872         IF Probe_addr(J,1)=I THEN
874             GOSUB Single_write
876             J=J+1
878         ELSE
880             PRINT "Not Used"
882         END IF
884     NEXT I
886     FOR I=1 TO Column2
888         PRINT TABXY(43,I+2);RPT$(" ",8);
890         PRINT TABXY(43,I+2);
892         IF Probe_addr(J,1)=I+Column1 THEN
894             GOSUB Single_write
896             J=J+1
898         ELSE
900             PRINT "Not Used"
902         END IF
904     NEXT I
906     FOR I=1 TO Column3
908         PRINT TABXY(73,I+2);RPT$(" ",8);
910         PRINT TABXY(73,I+2);
912         IF Probe_addr(J,1)=I+Column1+Column2 THEN
914             GOSUB Single_write
916             J=J+1
918         ELSE
920             PRINT "Not Used"
922         END IF
924     NEXT I
926     RETURN
928     !
930     ! //////////////////////////////////////
932     !
934 Single_write: !
936     PRINT USING "DD,X,#";Probe_addr(J,2)
938     SELECT Probe_addr(J,3)

```

```

940     CASE 1
942         PRINT "X"
944     CASE 2
946         PRINT "Y"
948     CASE 3
950         PRINT "Z"
952     CASE 4
954         PRINT "Sngl"
956     CASE ELSE
958         PRINT "ERROR"
960     END SELECT
962     RETURN
964     !
966     ! ///////////////////////////////////////////////////
968     !
970 Addprobe: !
972     Interrupted=1
974     IF Total_chans=Sys_size THEN
976         DISP " THERE IS A PROBE FOR EACH AMPLIFIER ALREADY "
978         BEEP
980         WAIT 1.8
982         DISP CHR$(12)
984         RETURN
986     END IF
988     FOR I=1 TO Total_chans
990         IF Probe_addr(I,1)=Selectpoint THEN
992             DISP " THIS CHANNEL IS ALREADY ACTIVE "
994             BEEP
996             WAIT 1.8
998             DISP CHR$(12)
1000             RETURN
1002         END IF
1004     NEXT I
1006     IF Total_chans<Sys_size THEN Total_chans=Total_chans+1
1008     Probe_addr(Total_chans,1)=Selectpoint
1010 Enterprobnum:!
1012     DISP "ENTER the index number for the probe ";
1014     LINPUT Test$
1016     ON ERROR GOTO Enterprobnum
1018     Probe_addr(Total_chans,2)=VAL(Test$)
1020     OFF ERROR
1022     IF Probe_addr(Total_chans,2)>MIN(Top_probe,99) THEN Enterprobnum
1024     IF Probe_addr(Total_chans,2)<1 THEN Enterprobnum
1026 Enterprobaxis:!
1028     LINPUT " ENTER THE ANTENNA AXIS (X,Y,Z, or Single (S) ",Test$
1030     SELECT UPC$(Test$[1,1])
1032     CASE "X"
1034         Probe_addr(Total_chans,3)=1
1036     CASE "Y"
1038         Probe_addr(Total_chans,3)=2
1040     CASE "Z"
1042         Probe_addr(Total_chans,3)=3
1044     CASE "S"
1046         Probe_addr(Total_chans,3)=4
1048     CASE ELSE
1050         Probe_addr(Total_chans,3)=99
1052         GOTO Enterprobaxis
1054     END SELECT
1056     PRINT CHR$(128);
1058     GOSUB Alreadyactive

```



```

1060      IF Duplicated THEN
1062          Probe_addr(Total_chans,1)=99
1064          Probe_addr(Total_chans,2)=0
1066          Probe_addr(Total_chans,3)=0
1068          Total_chans=Total_chans-1
1070          DISP " THIS PROBE IS ALREADY ACTIVE "
1072          BEEP
1074          WAIT 1.8
1076          DISP CHR$(12)
1078          RETURN
1080      END IF
1082      GOSUB Position_pen
1084      J=Total_chans
1086      GOSUB Single_write
1088      GOSUB Reset_pointer
1090      MAT SORT Probe_addr(*,1)
1092      RETURN
1094      !
1096      ! //////////////////////////////////////
1098      !
1100  Alreadyactive: ! Test for this probe already existing in the matrix.
1102      Duplicated=0
1104      FOR I=1 TO Total_chans-1
1106          IF Probe_addr(I,2)=Probe_addr(Total_chans,2) THEN
1108              IF Probe_addr(I,3)=Probe_addr(Total_chans,3) THEN
1110                  Duplicated=1
1112              END IF
1114          END IF
1116      NEXT I
1118      RETURN
1120      !
1122      ! //////////////////////////////////////
1124      !
1126  Changeprobe: !
1128      GOSUB Deleteprobe
1130      GOSUB Addprobe
1132      RETURN
1134      !
1136      ! //////////////////////////////////////
1138      !
1140  Deleteprobe: !
1142      Interrupted=1
1144      !Find the amplifier channel
1146      FOR I=1 TO Total_chans
1148          IF Probe_addr(I,1)=Selectpoint THEN
1150              Probe_addr(I,1)=99
1152              Probe_addr(I,2)=0
1154              Probe_addr(I,3)=0
1156              Total_chans=Total_chans-1
1158          END IF
1160      NEXT I
1162      GOSUB Position_pen
1164      PRINT "Not Used";
1166      GOSUB Reset_pointer
1168      MAT SORT Probe_addr(*,1)
1170      RETURN
1172      !
1174      ! //////////////////////////////////////
1176      !
1178  Read_disk: !

```

```

1180     Interrupted=1
1182     GOSUB Read_probe_disk
1184     GOSUB Print_probeaddr
1186     GOSUB Reset_pointer
1188     RETURN
1190     !
1192     ! ///////////////////////////////////////////////////
1194     !
1196 Read_probe_disk: !
1198     DISP " NOW READING IN THE PROBE CONFIGURATION FROM DISK "
1200     ON ERROR CALL Errortrap
1202     ASSIGN @Datapath TO "Probe_cnfg"&Sourcedisk$
1204     ENTER @Datapath;Test_size
1206     IF Test_size<>Sys_size THEN
1208         BEEP
1210         DISP " FILE is for system size of ";Test_size;" , the active";
1212         DISP " system is ";Sys_size
1214         PAUSE
1216         GOTO File_error
1218     END IF
1220     ENTER @Datapath;Total_chans
1222     ENTER @Datapath;Probe_addr(*)
1224 File_error: !
1226     ASSIGN @Datapath TO *
1228     OFF ERROR
1230     WAIT 1
1232     DISP CHR$(12)
1234     RETURN
1236     !
1238     ! ///////////////////////////////////////////////////
1240     !
1242 Saveondisk: !
1244     Interrupted=1
1246     DISP " SAVING THE PROBE CONFIGURATION ON DISK "
1248     ON ERROR GOTO Cannotcreate
1250     CREATE BDAT "Probe_cnfg"&Sourcedisk$,5,256
1252     GOTO Creation_done
1254 Cannotcreate: IF ERRN<>54 THEN
1256     CALL Errortrap
1258     GOTO Saveondisk
1260     END IF
1262 Creation_done: OFF ERROR
1264     ON ERROR CALL Errortrap
1266     ASSIGN @Datapath TO "Probe_cnfg"&Sourcedisk$
1268     OUTPUT @Datapath;Sys_size
1270     OUTPUT @Datapath;Total_chans
1272     OUTPUT @Datapath;Probe_addr(*)
1274     ASSIGN @Datapath TO *
1276     OFF ERROR
1278     WAIT 1
1280     DISP CHR$(12)
1282     RETURN
1284     !
1286     ! ///////////////////////////////////////////////////
1288     !
1290 List_addresses: !
1292     Interrupted=1
1294     PRINTER IS Printer
1296     PRINT RPT$("*",80)
1298     PRINT "TOTAL CHANNELS ENABLED =";Total_chans;

```

```

1300      PRINT ", System Size =";Sys_size
1302      PRINT
1304  Imagine:IMAGE M3D," -----",M3D," ----- ",6A,#
1306      IF INT(Sys_size/2)=Sys_size/2 THEN
1308          Poffset=INT(Sys_size/2)
1310      ELSE
1312          Poffset=INT(Sys_size/2)+1
1314      END IF
1316      PRINT " Amp#      Probe#      Channel#";
1318      PRINT TAB(40);" Amp#      Probe#      Channel#"
1320      FOR I=1 TO Poffset
1322          J=Probe_addr(I,1)
1324          K=Probe_addr(I,2)
1326          SELECT Probe_addr(I,3)
1328              CASE 1
1330                  Test$="X"
1332              CASE 2
1334                  Test$="Y"
1336              CASE 3
1338                  Test$="Z"
1340              CASE 4
1342                  Test$="Single"
1344              CASE ELSE
1346                  Test$="ERROR"
1348          END SELECT
1350          IF J<>99 THEN
1352              PRINT USING Imagine;J,K,Test$
1354          ELSE
1356              PRINT " ** end of file.";
1358              GOTO Done
1360          END IF
1362          IF I+Poffset<=Sys_size THEN
1364              J=Probe_addr(I+Poffset,1)
1366              K=Probe_addr(I+Poffset,2)
1368              SELECT Probe_addr(I+Poffset,3)
1370                  CASE 1
1372                      Test$="X"
1374                  CASE 2
1376                      Test$="Y"
1378                  CASE 3
1380                      Test$="Z"
1382                  CASE 4
1384                      Test$="Single"
1386                  CASE ELSE
1388                      Test$="ERROR"
1390              END SELECT
1392              IF J<>99 THEN
1394                  PRINT TAB(40);
1396                  PRINT USING Imagine;J,K,Test$
1398              ELSE
1400                  PRINT TAB(42); "***";
1402              END IF
1404          END IF
1406      PRINT
1408  NEXT I
1410 Done: PRINT USING "5/"
1412  PRINTER IS CRT
1414  RETURN
1416  !
1418  ! //////////////////////////////////////

```

```

1420      !
1422  SUBEND
1424      !
1426      ! *****
1428      !
1430  SUB Read_probes(@Gpio)
1432  Read_probes: !
1434      OPTION BASE 1
1436      COM /Probe_system/ INTEGER Sys_size,Total_chans,Probe_addr(*)
1438      COM /Probe_system/ INTEGER Top_probe,Fcal_pts,Pr_avgs
1440      COM /Probe_system/ INTEGER Probe_volts(*),Overrange(*)
1442      COM /Probe_system/ INTEGER Probe_zero(*),REAL Probe_v_m(*)
1444      COM /Probe_system/ REAL Amplitude_cal(*),Freq_cal(*)
1446      COM /Probe_system/ REAL Readtime(*),Freq_crib(*)
1448      COM /Bugs/ INTEGER Bug1,Bug2,Bug3,Printer
1450      COM /Interrupts/ INTEGER Intr_prty
1452      INTEGER I,F,Eir,Eir_bit,Readone,Ct10,Ct11
1454      INTEGER Power_off,Signbit
1456      ALLOCATE INTEGER Over_flag(Total_chans)
1458      ALLOCATE REAL Probe_ave(Total_chans)
1460      !
1462      IF Bug1 OR Bug2 THEN PRINTER IS Printer
1464      IF Bug1 THEN
1466          PRINT TIME$(TIMEDATE);" ***** ENTER Read_probes *****"
1468      END IF
1470      !
1472      IF Pr_avgs<1 THEN Pr_avgs=1
1474      MAT Probe_ave= (0.)
1476      MAT Over_flag= (0)
1478      MAT Probe_volts= (0)
1480      FOR I=1 TO Pr_avgs
1482          GOSUB Read_all_probes
1484          FOR P=1 TO Total_chans
1486              Probe_ave(P)=Probe_ave(P)+Probe_volts(P)
1488              Over_flag(P)=Over_flag(P) OR Overrange(P)
1490          NEXT P
1492      NEXT I
1494      FOR P=1 TO Total_chans
1496          Probe_volts(P)=INT(Probe_ave(P)/Pr_avgs)
1498          Overrange(P)=Over_flag(P)
1500      NEXT P
1502      IF Bug1 THEN
1504          PRINT TIME$(TIMEDATE);" ***** EXIT Read_probes *****"
1506      END IF
1508      IF Bug1 OR Bug2 THEN PRINTER IS CRT
1510      DEALLOCATE Probe_ave(*),Over_flag(*)
1512      SUBEXIT
1514      !
1516      ! //////////////////////////////////////
1518      !
1520  Read_all_probes: !
1522      MAT Readtime= (0.)
1524      MAT Probe_volts= (0)
1526      MAT Overrange= (0)
1528      IF Total_chans<1 THEN RETURN
1530      !
1532      ! SET Addr 1 and Check for power on at Probes via PFLG.
1534      !
1536      CONTROL 12,3;Probe_addr(1,1)
1538      STATUS 12,4;Power_off

```



```

1540 IF Power_off THEN
1542     DISP CHR$(129)
1544     DISP "The Power to Multi-probe is off....correct it.";
1546     DISP CHR$(128)
1548     BEEP
1550     PAUSE
1552     DISP CHR$(12)
1554 END IF
1556 !
1558 ! Initialize Track/Hold to TRACK with Start line low.
1560 !
1562 CONTROL 12,1;1 ! SET PCTL.
1564 Ctl0=1 ! SET. (START PULSE low)
1566 Ctl1=1 ! set (low....Track)
1568 CONTROL 12,2;Ctl0+Ctl1*2 ! Send values out.
1570 !
1572 IF Bug3 THEN PRINT "SETTING CTLO, CTL1 to INITIAL CONDITIONS."
1574 !
1576 ! Track signal
1578 !
1580 Ctl0=1 ! SET. (START PULSE low)
1582 Ctl1=1 ! set (low....Track)
1584 CONTROL 12,2;Ctl0+Ctl1*2 ! Send values out
1586 WAIT .01 ! Allow tracking for .01 sec.
1588 !
1590 ! Hold signal (only has meaning when High-Speed input enabled.)
1592 !
1594 Ctl0=1 ! Set (START PULSE low)
1596 Ctl1=0 ! clear (high....Hold)
1598 CONTROL 12,2;Ctl0+Ctl1*2 ! Send values out
1600 !
1602 ! Begin start pulse.
1604 !
1606 IF Bug3 THEN PRINT "SEND TRIGGER PULSE"
1608 Ctl0=0 ! CLEAR (START PULSE HIGH)
1610 Ctl1=0 ! Keep on HOLD.
1612 CONTROL 12,2;Ctl0+Ctl1*2 ! Send values out.
1614 Ctl0=1 ! SET (START PULSE LOW)
1616 Ctl1=0 ! SET TO HOLD.
1618 CONTROL 12,2;Ctl0+Ctl1*2 ! Send values out.
1620 !
1622 ! Check EIR bit low (BUSY is high) to insure the A/D is working.
1624 !
1626 STATUS 12,5;Eir
1628 Eir_bit=BIT(Eir,2)
1630 IF Eir_bit THEN
1632     DISP "A/D not responding to START pulse....Check conditions."
1634     BEEP
1636     PAUSE
1638 END IF
1640 !
1642 ! Set up interrupt and wait for BUSY to go low.
1644 ! Address is set to first Probe address already
1646 !
1648 ON INTR 12,15 GOTO Continue_reads
1650 ENABLE INTR 12;1
1652 IF Bug3 THEN PRINT TABXY(1,18);"WAITING FOR DATA READY"
1654 DISP CHR$(12)
1656 Bigtime=TIMEDATE
1658 P=1

```

```

1660     LOOP
1662         IF TIMEDATE-Bigtime>1.5 THEN GOSUB Interface_dead
1664     END LOOP
1666 Continue_reads:! Interrupt detected ... read channel 1
1668     STATUS 12,3;Probe_volts(1)
1670     Signbit=BIT(Probe_volts(1),12)
1672     Probe_volts(1)=BINAND(Probe_volts(1),4095)
1674     IF Signbit=1 THEN Probe_volts(1)=Probe_volts(1)-4096
1676     STATUS 12,5;Overrange(1)
1678     Overrange(1)=BIT(Overrange(1),3)
1680     Readtime(1)=TIMEDATE-Bigtime
1682     FOR P=2 TO Total_chans
1684         CONTROL 12,3;Probe_addr(P,1)
1686         !
1688         ! Check EIR bit high (BUSY is low)....ready to read
1690         !
1692         Bigtime2=TIMEDATE
1694         LOOP
1696             STATUS 12,5;Eir
1698             Eir_bit=BIT(Eir,2)
1700             EXIT IF Eir_bit
1702             IF TIMEDATE-Bigtime2>1.5 THEN GOSUB Interface_dead
1704         END LOOP
1706         STATUS 12,3;Probe_volts(P)
1708         Signbit=BIT(Probe_volts(P),12)
1710         Probe_volts(P)=BINAND(Probe_volts(P),4095)
1712         IF Signbit=1 THEN Probe_volts(P)=Probe_volts(P)-4096
1714         STATUS 12,5;Overrange(P)
1716         Overrange(P)=BIT(Overrange(P),3)
1718         Readtime(P)=TIMEDATE-Bigtime
1720     NEXT P
1722     ! CONTROL 12,3;Probe_addr(1,1)    !Reset to channel 1 ??
1724     !
1726     ! Reset Track/Hold to TRACK with Start line low.
1728     !
1730     Ctl0=1                                ! SET. (START PULSE low)
1732     Ctl1=1                                ! set (low....Track)
1734     CONTROL 12,2;Ctl0+Ctl1*2              ! Send values out.
1736     RETURN
1738     !
1740     ! //////////////////////////////////////
1742     !
1744 Interface_dead:!
1746     DISP CHR$(129)
1748     DISP " NO RESPONSE from channel ";Probe_addr(P,1);" ! ";
1750     DISP CHR$(128)
1752     BEEP
1754     WAIT 1.8
1756     DISP CHR$(12)
1758     Bigtime=TIMEDATE
1760     RETURN
1762     !
1764     ! //////////////////////////////////////
1766     !
1768 SUBEND
1770 !
1772 ! *****
1774 !
1776 SUB Probe_fill_cal
1778 Probe_fill_cal:!

```



```

1780      !
1782      !Fill the probe calibration matrix with values
1784      !
1786      OPTION BASE 1
1788      COM /Probe_system/ INTEGER Sys_size,Total_chans,Probe_addr(*)
1790      COM /Probe_system/ INTEGER Top_probe,Fcal_pts,Pr_avgs
1792      COM /Probe_system/ INTEGER Probe_volts(*),Overrange(*)
1794      COM /Probe_system/ INTEGER Probe_zero(*),REAL Probe_v_m(*)
1796      COM /Probe_system/ REAL Amplitude_cal(*),Freq_cal(*)
1798      COM /Probe_system/ REAL Readtime(*),Freq_crib(*)
1800      INTEGER I,J,K
1802      !
1804      IF Bug1 OR Bug2 THEN PRINTER IS Printer
1806      IF Bug1 THEN
1808          PRINT TIME$(TIMEDATE);" ***** ENTER Probe_fill_cal *****"
1810      END IF
1812      DISP " Filling Amplitude calibration array. "
1814      Calib_curvefit: !
1816          ! fit to Field (V/m)= a(Decimal output)^b
1818          ! where a1,b1 is for <low-high crossing
1820          ! and a2,b2 is for >=low-high crossing
1822      RESTORE Calib_curvefit
1824      !      a1      b1      a2      b2  low-high crossing
1826      DATA 4.75115,.554942,1.67252,.755931,175      ! 1X
1828      DATA 4.21950,.562912,1.51002,.760065,189      ! 1Y
1830      DATA 3.80279,.591157,1.63280,.751374,200      ! 1Z
1832      !
1834      DATA 4.13591,.578563,1.65858,.755074,170      ! 2X
1836      DATA 4.09156,.568407,1.50863,.760301,180      ! 2Y
1838      DATA 3.90861,.579196,1.53843,.757005,180      ! 2Z
1840      !
1842      DATA 4.77555,.570532,1.88350,.751508,190      ! 3X
1844      DATA 4.48032,.550087,1.47673,.763525,170      ! 3Y
1846      DATA 4.42092,.556629,1.55505,.759144,175      ! 3Z
1848      !
1850      DATA 4.70342,.542879,1.61699,.749880,175      ! 4X
1852      DATA 4.42551,.554332,1.54252,.757989,180      ! 4Y
1854      DATA 4.35856,.558571,1.54460,.759468,175      ! 4Z
1856      !
1858      DATA 3.67584,.578890,1.39243,.763700,190      ! 5X
1860      DATA 4.36056,.548574,1.40885,.766072,175      ! 5Y
1862      DATA 4.21723,.559496,1.49515,.759377,180      ! 5Z
1864      !
1866      FOR I=1 TO Top_probe
1868          FOR J=1 TO 3      ! 3 channels; x,y,z or s,0,0
1870              FOR K=1 TO 5      ! a1,b1,a2,b2,l-h crossing
1872                  READ Amplitude_cal(I,J,K)
1874              NEXT K
1876          NEXT J
1878      NEXT I
1880      WAIT 1
1882      !
1884      !Fill frequency response data
1886      !
1888      Freq_caldata:!
1890      DISP " Filling Frequency calibration array. "
1892      RESTORE Freq_caldata
1894      DATA 300,1,500,.894,1000,.689,2000,.825,5000,.820,8000,.857 ! 1-X
1896      DATA 300,1,500,.898,1000,.702,2000,.860,5000,.874,8000,.941 ! 1-Y
1898      DATA 300,1,500,.900,1000,.687,2000,.814,5000,.796,8000,.835 ! 1-Z

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1900      !
1902      DATA 300,1,500,.916,1000,.673,2000,.783,5000,.715,8000,.740 ! 2-X
1904      DATA 300,1,500,.915,1000,.680,2000,.796,5000,.733,8000,.740 ! 2-Y
1906      DATA 300,1,500,.908,1000,.664,2000,.779,5000,.712,8000,.726 ! 2-Z
1908      !
1910      DATA 300,1,500,.900,1000,.682,2000,.749,5000,.783,8000,.829 ! 3-X
1912      DATA 300,1,500,.921,1000,.706,2000,.750,5000,.793,8000,.852 ! 3-Y
1914      DATA 300,1,500,.913,1000,.690,2000,.745,5000,.746,8000,.776 ! 3-Z
1916      !
1918      DATA 300,1,500,.888,1000,.698,2000,.807,5000,.731,8000,.757 ! 4-X
1920      DATA 300,1,500,.866,1000,.684,2000,.801,5000,.753,8000,.803 ! 4-Y
1922      DATA 300,1,500,.883,1000,.700,2000,.802,5000,.755,8000,.813 ! 4-Z
1924      !
1926      DATA 300,1,500,.908,1000,.714,2000,.830,5000,.710,8000,.718 ! 5-X
1928      DATA 300,1,500,.917,1000,.713,2000,.823,5000,.755,8000,.803 ! 5-Y
1930      DATA 300,1,500,.922,1000,.720,2000,.819,5000,.716,8000,.742 ! 5-Z
1932      !
1934      FOR I=1 TO Top_probe
1936          FOR J=1 TO 3                ! 3 channels; x,y,z or s,0,0
1938              FOR K=1 TO Fcal_pts    ! The frequencies where cal is done
1940                  READ Freq_cal(I,J,K,1),Freq_cal(I,J,K,2)
1942              NEXT K
1944          NEXT J
1946      NEXT I
1948      IF Bug1 THEN
1950          PRINT TIME$(TIMEDATE);" ***** EXIT Probe_fill_cal *****"
1952      END IF
1954      IF Bug1 OR Bug2 THEN PRINTER IS CRT
1956      DISP CHR$(12)
1958      SUBEXIT
1960  SUBEND
1962      !
1964      ! *****
1966      !
1968      SUB Apply_probe_cal (REAL Frequency)
1970  Apply_probe_cal: ! Convert the decimal A/D output to V/m
1972      OPTION BASE 1
1974      COM /Probe_system/ INTEGER Sys_size,Total_chans,Probe_addr(*)
1976      COM /Probe_system/ INTEGER Top_probe,Fcal_pts,Pr_avgs
1978      COM /Probe_system/ INTEGER Probe_volts(*),Overrange(*)
1980      COM /Probe_system/ INTEGER Probe_zero(*),REAL Probe_v_m(*)
1982      COM /Probe_system/ REAL Amplitude_cal(*),Freq_cal(*)
1984      COM /Probe_system/ REAL Readtime(*),Freq_crib(*)
1986      COM /Bugs/ INTEGER Bug1,Bug2,Bug3,Printer
1988      INTEGER I,J,K,L,M,Amp,Probe,Zer,A_d,Org,Nogood
1990      REAL A,B,V_m,Fcal,Lhc
1992      DIM Ax$(1)
1994      ! IF Bug1 OR Bug2 THEN PRINTER IS Printer
1996      IF Bug1 THEN
1998          PRINT TIME$(TIMEDATE);" ***** ENTER Apply_probe_cal *****"
2000      END IF
2002      IF Bug2 THEN ! Tabulate the numbers, print heading.
2004          PRINT RPT$("_",80)
2006          PRINT "Frequency=";Frequency
2008          PRINT "Amp# Probe# Axis Zero      A/D  Ovrng?      a  (aX^b)  b";
2010          PRINT "          Fcal => Volts/mtr"
2012      END IF
2014      !
2016      ! Subtract the zero field offset.
2018      !

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2020      MAT Probe_volts= Probe_volts-Probe_zero
2022      FOR I=1 TO Total_chans
2024          ! Determine probe index pointers.
2026          J=Probe_addr(I,2)          ! Probe index number
2028          K=Probe_addr(I,3)          ! channel index number
2030          IF K>3 THEN K=1            ! Single channel uses slot 1.
2032          !
2034          ! GET AMPLITUDE calibration curvefit coefficients.
2036      Apply_am_cal: !
2038          !Amplitude_cal(J,K,5)=Low-high crossing value for curvefit coef.
2040          IF Probe_volts(I)>=Amplitude_cal(J,K,5) THEN
2042              !select high range coef.
2044              L=3
2046              M=4
2048          ELSE
2050              !select low range coef.
2052              L=1
2054              M=2
2056          END IF
2058          A=Amplitude_cal(J,K,L)
2060          B=Amplitude_cal(J,K,M)
2062      Apply_fr_cal: !
2064          ! GET frequency calibration data.
2066          ! Copy this channel's frequency cal data into Freq_crib(*)
2068          FOR L=1 TO Fcal_pts
2070              Freq_crib(L,1)=Freq_cal(J,K,L,1)
2072              Freq_crib(L,2)=Freq_cal(J,K,L,2)
2074          NEXT L
2076          CALL Get_cal_value(Frequency,Fcal,Freq_crib(*),Nogood,Fcal_pts)
2078          !
2080          ! SOCK it to the A/D output ... convert to Volts/meter?
2082          !
2084          IF Probe_volts(I)<0 THEN Probe_volts(I)=0
2086          Probe_v_m(I)=(A*(Probe_volts(I))^B)*Fcal
2088          !
2090          IF Bug2 THEN
2092              Amp=Probe_addr(I,1)
2094              Probe=Probe_addr(I,2)
2096              SELECT Probe_addr(I,3)
2098              CASE 1
2100                  Ax$="X"
2102              CASE 2
2104                  Ax$="Y"
2106              CASE 3
2108                  Ax$="Z"
2110              CASE 4
2112                  Ax$="S"
2114              CASE ELSE
2116                  Ax$="E"
2118              END SELECT
2120              Org=Overrange(I)
2122              Zer=Probe_zero(I)
2124              A_d=Probe_volts(I)
2126              V_m=Probe_v_m(I)
2128      Image1:      IMAGE M3D,2X,M3D,3X,A,3X,2(M4D,2X),MDD,2X,3(MD.6D,2X),M4D.2D
2130                  PRINT USING Image1;Amp,Probe,Ax$,Zer,A_d,Org,A,B,Fcal,V_m
2132          END IF
2134      NEXT I
2136      IF Bug2 THEN PRINT RPT$("_",80)
2138      IF Bug1 THEN

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2140         PRINT TIME$(TIMEDATE);" ***** EXIT Apply_probe_cal *****"
2142     END IF
2144     IF Bug1 OR Bug2 THEN PRINTER IS CRT
2146     SUBEXIT
2148 SUBEND
2150 !
2152 ! *****
2154 !
2156 SUB Get_cal_value(REAL Target,Result,File(*),INTEGER Baddata,Endpoint)
2158 !
2160 ! Original: 17 Jan 1984, by G. Koepke and Darlene Agee
2162 ! Revision: 26 Sep 1985, by G. Koepke
2164 !
2166 ! This routine will search the matrix of data using the binary-
2168 ! search method until the desired X value is bracketed. Using
2170 ! the bracket values for Y the resulting Y value for the desired
2172 ! X value is found by linear interpolation.
2174 !
2176 ! Target=desired X as given during CALL.
2178 ! X_low=Low value of X used during binary search
2180 ! X_high=High " " " " " "
2182 ! I_low=Index of low X " " " "
2184 ! I_high=Index of High X " " " "
2186 ! I_cntr=Index of half way point.
2188 !
2190 OPTION BASE 1
2192 COM /Bugs/ INTEGER Bug1,Bug2,Bug3,Printer
2194 REAL X_low,Y_low,X_high,Y_high
2196 INTEGER I_low,I_high,I_cntr,Target_found
2198 !
2200 IF Bug1 THEN
2202     PRINT TIME$(TIMEDATE);
2204     PRINT "***** Begin Search for X=";Target;" in File *****"
2206 END IF
2208 !
2210 GOSUB Check_endpts
2212 IF Baddata OR Target_found THEN Go_home
2214 GOSUB Search_file
2216 GOSUB Interpolate
2218 Go_home: !
2220 IF Bug1 THEN
2222     PRINT TIME$(TIMEDATE);
2224     PRINT "***** End Search, returning Y=";Result;" *****"
2226 END IF
2228 SUBEXIT
2230 !
2232 ! //////////////////////////////////////
2234 !
2236 Check_endpts: !Check condition of file and verify Target is in range.
2238     Target_found=0
2240     Baddata=0
2242     Result=0
2244     IF Endpoint>0 THEN
2246         IF Target<File(1,1) OR Target>File(Endpoint,1) THEN
2248             Baddata=1
2250             Result=1.0
2252             IF Bug1 THEN
2254                 PRINT "Desired X-value outside range of data.";
2256                 PRINT " Returning Y-value of 1.0 *****"
2258                 PRINT "Range=";File(1,1);" to ";File(Endpoint,1);

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2260             PRINT "; Desired value=";Target
2262         END IF
2264     ELSE
2266         IF Endpoint<2 AND Target=File(1,1) THEN !Only one data point
2268             Result=File(1,2)
2270             Target_found=1
2272         END IF
2274     END IF
2276 ELSE
2278     Baddata=1
2280     Result=1.0
2282     IF Bug1 THEN
2284         PRINT "This file is empty! ";
2286         PRINT " Returning Y-value of 1.0 *****"
2288     END IF
2290 END IF
2292 RETURN
2294 !
2296 ! ///////////////////////////////////////////////////////////////////
2298 !
2300 Search_file: ! Target exists within X_low to X_high
2302 ! and file has at least two entries.
2304 !
2306     I_low=1
2308     I_high=Endpoint
2310     I_cnr=INT((I_high-I_low)/2)+I_low
2312     X_low=File(I_low,1)
2314     X_high=File(I_high,1)
2316     IF Bug3 THEN
2318         PRINT "---- Searching for ";Target;" ----"
2320         GOSUB Trace_search
2322     END IF
2324     IF (I_cnr=I_low) OR (Target=X_low) OR (Target=X_high) THEN Bullseye
2326     REPEAT
2328         IF Target>=File(I_cnr,1) THEN
2330             I_low=I_cnr
2332             X_low=File(I_low,1)
2334         ELSE
2336             I_high=I_cnr
2338             X_high=File(I_high,1)
2340         END IF
2342         I_cnr=INT((I_high-I_low)/2)+I_low
2344         IF Bug3 THEN GOSUB Trace_search
2346     UNTIL (I_cnr=I_low) OR (Target=X_low) OR (Target=X_high)
2348 Bullseye: !
2350     IF Bug3 THEN PRINT "---- Search ended. ----"
2352     RETURN
2354     !
2356     ! ///////////////////////////////////////////////////////////////////
2358     !
2360 Trace_search: ! Print search parameters as they change.
2362     PRINT "Low I,X=";I_low;"",X_low;
2364     PRINT " High I,X=";I_high;"",X_high;
2366     PRINT " Center I,X=";I_cnr;"",File(I_cnr,1)
2368     RETURN
2370     !
2372     ! ///////////////////////////////////////////////////////////////////
2374     !
2376 Interpolate: !
2378     Y_low=File(I_low,2)

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```

2380     Y_high=File(I_high,2)
2382     !
2384     IF ABS(X_high-X_low)>1.0E-10 THEN !Not same X value
2386         Result=((Y_high-Y_low)/(X_high-X_low))*(Target-X_low)+Y_low
2388     ELSE
2390         Result=(Y_high+Y_low)/2
2392     END IF
2394     !
2396     IF Bug3 THEN PRINT "Desired freq.=";Target;"      VALUE=";Result
2398     !Result=10.^(Result/10)
2400     !IF Bug3 THEN PRINT "Desired freq.=";Target;"  RATIO=";Result
2402     RETURN
2404     !
2406     ! //////////////////////////////////////
2408     !
2410 SUBEND
2412 !
2414 ! *****
2416 !
2418 SUB Errortrap
2420     !Trap disk errors here
2422     !
2424     COM /Files/ Diskin$,Diskout$,Filename$
2426     BEEP 400,.6
2428     SELECT ERRN
2430     CASE 54
2432         DISP "DUPLICATE FILE NAME: ";Filename$;
2434         DISP "...PURGE old one? (Y/N)";
2436         INPUT Test$
2438         SELECT Test$[1,1]
2440         CASE "Y","y"
2442             PURGE Filename$&Diskout$
2444         CASE ELSE
2446             DISP "ENTER NEW FILE NAME";
2448             LINPUT Filename$
2450         END SELECT
2452     CASE 52,53
2454         DISP "Improper FILE NAME --- ENTER NEW FILE NAME";
2456         OUTPUT 2 USING "K,#";Filename$
2458         LINPUT Filename$
2460     CASE 64
2462         DISP "This disk is full, PLEASE insert clean disk"
2464         PAUSE
2466     CASE 80
2468         DISP "CHECK DISK drive door! ";
2470         DISP " ...CONTINUE when ready"
2472         PAUSE
2474     CASE ELSE
2476         DISP ERRM$;" 'CONTINUE' when fixed"
2478         PAUSE
2480     END SELECT
2482     DISP CHR$(12)
2484     SUBEXIT
2486 SUBEND
2488 !
2490 ! *****
2492 !

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